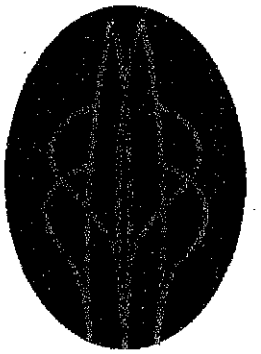

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MODELING THE HYDRODYNAMICS OF A MIXTURE OF NATURAL GAS & WATER IN A SUPERSONIC SEPARATOR

by

IDA AMEERA BINTI RAMLI

10672

Dissertation submitted in partial fulfilment of the requirements for the

Bachelor (Hons.) of Chemical Engineering

SEPTEMBER 2011

Universiti Teknologi PETRONAS

Bandar Seri Iskandar

31750 Tronoh

CERTIFICATION OF APPROVAL

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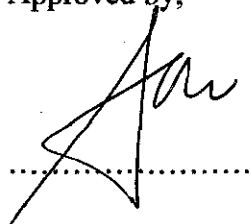
Approved by,



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(DR. LAU KOK KEONG)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

SEPTEMBER 2011

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TABLE OF CONTENT

CERTIFICATION OF APPROVAL i

CERTIFICATION OF ORIGINALITY ii

ABSTRACT iii

ACKNOWLEDGEMENT iv

LIST OF FIGURES viii

LIST OF TABLES ix

ABBREVIATIONS and NOMENCLATURES ix

CHAPTER 1: INTRODUCTION 1

1.1: Project Background 1

1.2: Problem Statement 2

1.3: Objective & Scope of Study 2

CHAPTER 2: LITERATURE REVIEW 3

2.1: Twister™ Supersonic Gas Separator 3

2.1.1: Working Principal 3

2.1.2: Benefits 4

2.1.3: Applications in Industry 4

2.2: De Laval Nozzle 5

2.3: Supersonic Velocity 6

2.4: Governing Equations 7

2.4.1: Momentum Equation 7

2.4.2: Mass Equation 8

2.4.3: Compressible Flow 8

2.5: Gas Hydrate 9

2.6: Other Water Removal Techniques 10

2.6.1: Dehydration Using TEG 10

2.6.2: Dry – Bed Dehydration 10
CHAPTER 3: METHODOLOGY 11
3.1: Modelling the Nozzle 12
3.1.1: Nozzle Geometry 12
3.1.2: Mesh 13
3.1.3: FLUENT 15
3.2: Grid Size Optimization 16
3.3: Manipulated Variable – Throat Diameter 17
3.4: Manipulated Variable – Inlet Pressure 17
CHAPTER 4: RESULTS & DISCUSSION 18
4.1: Grid Size Optimization 18
4.2: Water Vapour Hydrodynamics Simulation 19
4.2.1: Static Pressure Profile 19
4.2.2: Mach Number Profile 20
4.3: Manipulated Variable – Throat Diameter 22
4.3.1: Static Pressure Profile 22
4.3.2: Mach Number Profile 23
4.4: Manipulated Variable – Inlet Pressure 24
4.4.1: Static Pressure Profile 24
4.4.2: Mach Number Profile 25
CHAPTER 5: CONCLUSION & RECOMMENDATION 26
REFERENCES x
APPENDIX I: PROJECT TIMELINE FOR FYP I xi
APPENDIX II: PROJECT TIMELINE FOR FYP II xii
APPENDIX III: GRID SIZE OPTIMIZATION DATA (MESH 1 - 4) xiii
APPENDIX IV: GRID SIZE OPTIMIZATION DATA (MESH 5 - 8) xxv
APPENDIX V: HYDRODYNAMICS SIMULATION DATA 1

LIST OF FIGURES

Figure 1: The Cross-Section of a Twister Tube with Typical Process Conditions; (Twister BV, 2011) 3
Figure 2: A Gas Hydrate Plug Formed in a Subsea Hydrocarbon Pipeline. Picture courtesy of Petrobras (Brazil). 9
Figure 3: Work Sequence for Final Year Project I 11
Figure 4: Work Sequence for Final Year Project II 11
Figure 5: Front View of the Converging-Diverging Nozzle Geometry 13
Figure 6: Edge Sizing for Mesh Generation 13
Figure 7: Meshing Results 14
Figure 8: Close-Up View of Mesh Elements 14
Figure 9: Solution Initialization Settings 15
Figure 10: Partial View of Mesh 7 16
Figure 11: Points 1 and 2 on Geometry 17
Figure 12: Velocity Profile for Different Mesh 18
Figure 13: Comparison between Simulation Result and Published Result by Yang, Y. & Shen, S. (2009) 19
Figure 14: Mach Number Profile Along Nozzle Symmetry 20
Figure 15: Effect of Nozzle Throat Diameter on the Static Pressure Profile 22
Figure 16: Effect of Nozzle Throat Diameter on Mach Number Profile 23
Figure 17: Effect of Inlet Pressure on Static Pressure Profile 24
Figure 18: Effect of Inlet Pressure on Mach Number Profile 25

LIST OF TABLES

Table 1: Mach Number Categories 6
Table 2: Geometry of the Converging-Diverging Nozzle 12
Table 3: Edge Sizing Specification for Meshing 14
Table 4: Grid Size Optimization Meshing Specifications 16
Table 5: Different Throat Diameters 17
Table 6: Different Inlet Pressures 17
Table 7: Mach Number Near the Throat for Different Geometries 23

ABBREVIATIONS AND NOMENCLATURES

a	Speed of Sound in the Medium (m/s)
A	Cross-Sectional Area (m^2)
A*	Throat Cross-Sectional Area (m^2)
BTX	Benzene Toluene Xylene
Cp	Specific Heat Capacity
D_t	Throat Diameter
F_x, F_r	Axial, Radial Model Dependent Source Term
γ	Specific Heat Ration ($\gamma_{air} = 1.4$)
M	Mach Number
P	Static Pressure
ρ	Density
r	Radius
R	Ideal Gas Constant
S_m	Mass Added
T	Temperature
™	Trademark
TSCF	Trillion Standard Cubic Feet
v_x, v_r	Axial, Radial Velocity (m/s)
VOC	Volatile Organic Compound
x	Axial Length

CHAPTER 1: INTRODUCTION

1.1: Project Background

Natural gas is one of the major energy sources in the world. Its' major usage includes power generation, as transportation fuel and as raw material to produce ammonia and other petrochemical products.

BP Global (2011) stated that the world consumption of natural gas for the past year has increased 7.4%. This is the highest increase since 1984. Among the major importers of natural gas are UK, Japan and South Korea. Both Japan and South Korea, who are the world's largest and second largest LNG importers respectively, receive their supply from Malaysia.

As of January 2011, Malaysia has 83 Trillion Standard Cubic Feet (TSCF) of natural gas in proven reserves, (Oil & Gas Journal, 2011). This places Malaysia in the fourth place as the country in Asia Pacific with the most natural gas in reservoir. The exploration and production activities in Malaysia are intensive and it is estimated in 2010 that the gross natural gas production is 2.7 TSCF.

A typical composition of natural gas before it is refined contains hydrocarbon, nitrogen, carbon dioxide and hydrogen sulphide. Natural gas production often produces water as well. This water must be removed as it can pose many problems such as the formation of hydrates. Hydrates are solids formed by methane, carbon dioxide and water. It can clog the pipelines, thus decreasing the flow efficiency.

Furthermore, water can also combine with hydrogen sulphide and carbon dioxide to form acid. This acid corrodes the pipelines transporting gas to onshore. As a result, high cost is incurred as a special anti-corrosive material is needed to coat the pipeline. To avoid these problems, water must be removed from natural gas.

1.2: Problem Statement

Dehydration of water from natural gas is conventionally done using triethylene glycol (TEG). However this process is harmful to the environment as it releases BTX and VOC's to the atmosphere. Therefore, an environmental-friendly method to remove water is needed.

Supersonic Gas Separator is a nozzle that can separate two components from a single phase mixture. It is based on the concept of condensation and separation at supersonic velocity.

1.3: Objective & Scope of Study

The scope of this study will be focusing on the hydrodynamics behaviour of a mixture of natural gas and water in the supersonic gas separator.

i. To model the hydrodynamics (pressure and velocity) in supersonic separator for water dehydration.
ii. To validate the model by comparing the simulated result with the experimental result.

CHAPTER 2: LITERATURE REVIEW

2.1: Twister™ Supersonic Gas Separator

Twister BV is one of the two companies in the world that specializes in supersonic gas separator. Although it is a relatively new technology, its' fundamental physical concept has been known for a long time.

2.1.1: Working Principal

The device works in a simple way that is described by Brouwer and Epsom (2003). Saturated feed, i.e. natural gas is flowed into a laval nozzle and is expanded to supersonic velocity. This results in a high temperature and pressure drop which will cause water and certain hydrocarbon to be condensed.

The flow will then be centrifuged by a wing installed in the supersonic flow regime. A high vorticity swirl will be generated, causing the droplets to be forced to the nozzle's wall. A cyclone separator then separates the liquid from gas.

In order to slow down the separate streams, a diffuser is installed. It can recover 65 – 80% of the initial pressure. However, the liquid stream will still contain some slip-gas. This will be removed in a compact liquid de-gassing vessel and will then be recombined with the dry gas stream. Figure 1 below illustrates the cross section of Twister™ Supersonic Gas Separator.

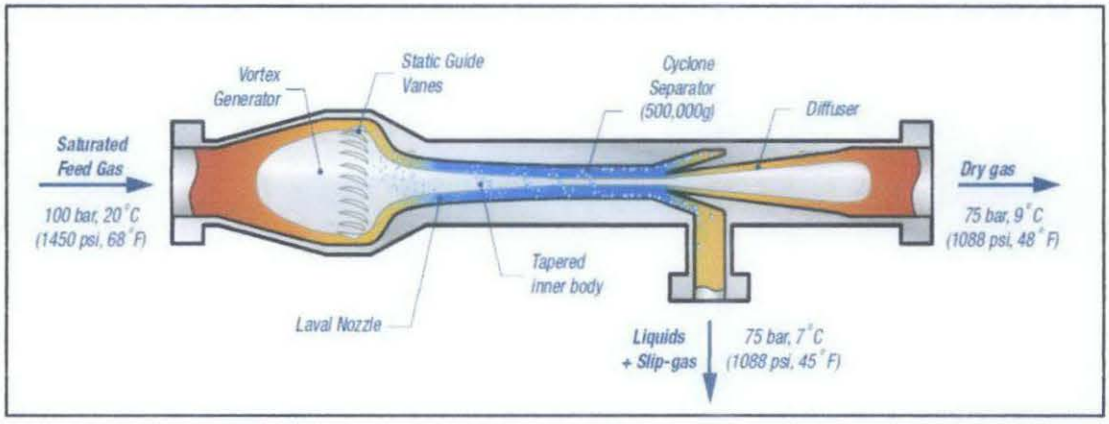

Figure 1: The Cross-Section of a Twister Tube with Typical Process Conditions; (Twister BV, 2011)

2.1.2: Benefits

This device incorporates condensation and separation at supersonic velocity. Due to this, it has many benefits compared to other separation technologies. For instance, the supersonic speed causes the residence time of natural gas inside the tube to be only milliseconds (Brouwer & Epsom, 2003).

Thus, there is not enough time for hydrates to be formed. This eliminates the need for chemicals to inhibit hydrate formation. Furthermore, the regeneration of these chemicals will release harmful BTX to the environment. With the use of Twister™ tubes, this phenomenon can be avoided.

Twister™ supersonic gas separator has no rotating parts and is a fairly small equipment. For a typical production of 35 MMsfcd at 100 bar, a Twister™ tube is only 2 meters long inside a 150 mm casing. This makes it a reliable device that is suitable for installation in unmanned operation in harsh condition or at offshore environments.

2.1.3: Applications in Industry

Twister™ Supersonic Gas Separator has the ability to efficiently separate water and heavy hydrocarbon from natural gas. In the oil and gas industry, its' applications include water dewpointing, hydrocarbon dewpointing and natural gas liquids recovery.

At a gas processing plant in Nigeria owned and operated by Shell Petroleum Development Company, this equipment is used to condition the fuel gas. Furthermore, Twister™ tubes has been commissioned by PETRONAS to process the natural gas produced in East Malaysia since 2003.

2.2: De Laval Nozzle

De laval nozzle, or also known as converging – diverging nozzle is a tube that is has varying diameters. The inlet diameter is converged in the middle of the tube, i.e. it is getting smaller. The smallest diameter of the tube is called the throat. After the throat, the tube's diameter diverges, which means that the cross sectional area is increasing. Due to its' asymmetrical hourglass shape, a pressurised gas passing through the nozzle will be accelerated to supersonic speed.

Initially, the gas at inlet is flowing at subsonic speed. Because the mass flow rate is kept constant, when the tube converges, the decreasing cross sectional area will cause the velocity to increase. At the throat, the gas velocity reaches sonic speed; this condition is called choked flow. the diverging section further accelerates the gas, until it reaches supersonic speed.

In order to achieve supersonic velocity, the flow must be sonic at the throat. Otherwise, the tube will act as a Venturi tube where there is only a pressure drop in the tube. Thus, the pressure and mass flow rate through the nozzle must be sufficient to achieve sonic speed.

The gas flow at subsonic and supersonic speed is isentropic, i.e. it has constant entropy. Thus, it becomes reversible and adiabatic. However, as it reaches sonic speed, compressibility effect must be taken into consideration. Due to this, there is a density change along the nozzle. This also impacts the temperature of the flow, which decreases from inlet to outlet.

Furthermore, shock waves can form when the flow reaches supersonic velocity. It occurs because the gas is moving too fast, the effect it has onto the surrounding area is not propagated in enough time. Thus there is an instantaneous change in the gas properties such as pressure, density, temperature and etc. In the case of de laval nozzle, there is a significant pressure and temperature drop across the shock wave.

2.3: Supersonic Velocity

Supersonic velocity is when an object or fluid travels faster than the speed of sound. Its' measurement unit is Mach number; it is defined as below

$$M = \frac{V}{a}$$

Where

M = Mach Number

V = relative velocity of the source to the medium

a = speed of sound in the medium

Thus, a Mach number of 1 is equivalent to the speed of sound, whilst supersonic flow has a Mach number of more than 1, but less than 5. The speed of sound is the distance travelled during a unit of time by a sound wave propagating through an elastic medium. In dry air at 20 °C, the speed of sound is 343.2 m/s or 1236 km/h. However, different mediums have different speed of sounds.

The medium properties affect the speed of sound; in solids, the speed of longitudinal waves depends on the stiffness to tensile stress and its' density. On the other hand, in fluids, compressibility and density are more important. Since compressibility and density are related for gas, other compositional effects and properties such as temperature and molecular composition can affect the speed of sound.

For example, sound propagates faster in low molecular weight gases such as helium compared to heavier gases. In ideal gases, speed of sound depends only on temperature because pressure and density have equal but opposite effects, thus they cancel each other out. But in non-ideal gases, the proportionality is not exact; therefore, pressure is also affecting the speed of sound. The summary of Mach number classification is listed in the table below.

Table 1: Mach Number Categories

Regime	Subsonic	Transonic	Sonic	Supersonic	Hypersonic
Mach	< 1.0	0.8 – 1.2	1.0	1.2 – 5.0	5.0 – 10.0

2.4: Governing Equations

The basic governing equations for a flowing fluid is the Navier-Stokes equation. It is a vector equation obtained by applying the Newton's Law of Motion to a fluid and is also known as the momentum equation. Furthermore, this equation must be solved together with continuity equation and energy equation for a complete picture of momentum, mass and energy conservation.

2.4.1: Momentum Equation

The axial momentum conservation equation for a 2D axisymmetric geometry (ANSYS, 2009) is given as below;

$$\frac{\partial}{\partial t}(\rho v_x) + \frac{1}{r}\frac{\partial}{\partial x}(r\rho v_x v_x) + \frac{1}{r}\frac{\partial}{\partial r}(r\rho v_r v_x) = -\frac{\partial p}{\partial x} + \frac{1}{r}\frac{\partial}{\partial x}\left[r\mu\left(2\frac{\partial v_x}{\partial x} - \frac{2}{3}(\nabla.\vec{v})\right)\right] + \frac{1}{r}\frac{\partial}{\partial r}\left[r\mu\left(\frac{\partial v_x}{\partial r} + \frac{\partial v_r}{\partial x}\right)\right] + F_x$$

Whereas the radial momentum conservation equation (ANSYS, 2009) is given below;

$$\frac{\partial}{\partial t}(\rho v_r) + \frac{1}{r}\frac{\partial}{\partial x}(r\rho v_x v_r) + \frac{1}{r}\frac{\partial}{\partial r}(r\rho v_r v_r) = -\frac{\partial p}{\partial r} + \frac{1}{r}\frac{\partial}{\partial x}\left[r\mu\left(\frac{\partial v_r}{\partial x} + \frac{\partial v_x}{\partial r}\right)\right] + \frac{1}{r}\frac{\partial}{\partial r}\left[r\mu\left(2\frac{\partial v_r}{\partial r} - \frac{2}{3}(\nabla.\vec{v})\right)\right] - 2\mu\frac{v_r}{r^2} + \frac{2}{3}\frac{\mu}{r}(\nabla.\vec{v}) + \rho\frac{v_z^2}{r} + F_r$$

Where

$$\nabla.\vec{v} = \frac{\partial v_x}{\partial x} + \frac{\partial v_r}{\partial r} + \frac{v_r}{r}$$

p is the static pressure, v_z is the swirl velocity and F_x and F_r are the other model-dependent source terms for axial and radial momentum respectively.

2.4.2: Mass Equation

The mass conservation equation (ANSYS, 2009), or also known as continuity equation can be written generally as below, where S_m is the mass added to the continuous phase from the dispersed second phase.

$$\frac{\partial \rho}{\partial t} + \nabla . (\rho \vec{v}) = S_m$$

For 2D axisymmetric geometry, the continuity equation (ANSYS, 2009) is as below; where x is the axial coordinate, r is the radial coordinate, v_z is the axial velocity and v_r is the radial velocity.

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x}(\rho v_z) + \frac{\partial}{\partial r}(\rho v_r) + \frac{\rho v_r}{r} = S_m$$

2.4.3: Compressible Flow

At very low Mach speeds, i.e. M < 0.1, compressibility effects are negligible; thus the variation of gas density with pressure is ignored. However, at speeds approaching sonic, compressibility effect is significant. The total pressure, p_o and total temperature T_o for an ideal gas compressible flow (ANSYS, 2009) are related as below;

$$\frac{p_o}{p} = exp\left(\frac{\int_T^{T_o} \frac{C_p}{T} dT}{R}\right)$$

At constant Cp (ANSYS, 2009),

$$\frac{p_o}{p} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{\gamma/(\gamma-1)}$$

$$\frac{T_o}{T} = 1 + \frac{\gamma - 1}{2} M^2$$

2.5: Gas Hydrate

Gas hydrate is formed from the crystallization of water in the presence of natural gas. It normally occurs in pipelines where the high pressure and low temperature causes water to be crystallized. However, some amount of methane, carbon dioxide or hydrogen sulphide is trapped inside the ice structure, thus the formation of hydrates.

Hydrates can clog the pipelines and processing equipment, therefore it must be removed. One of the removal methods is to dissolve hydrates using chemical such as methanol. However, it is more preferable to prevent the formation of hydrates rather than treating it.

Prevention methods include removing water from natural gas or by using antifreeze chemicals that depress the temperature at which hydrates form. There are also hydrate inhibitors such as Kinetic Hydrate Inhibitors that slows the hydrate formation rate. In addition, anti-agglomerates do not prevent hydrate formation; instead, it prevents hydrate from sticking to each other and consequently blocking the pipelines.

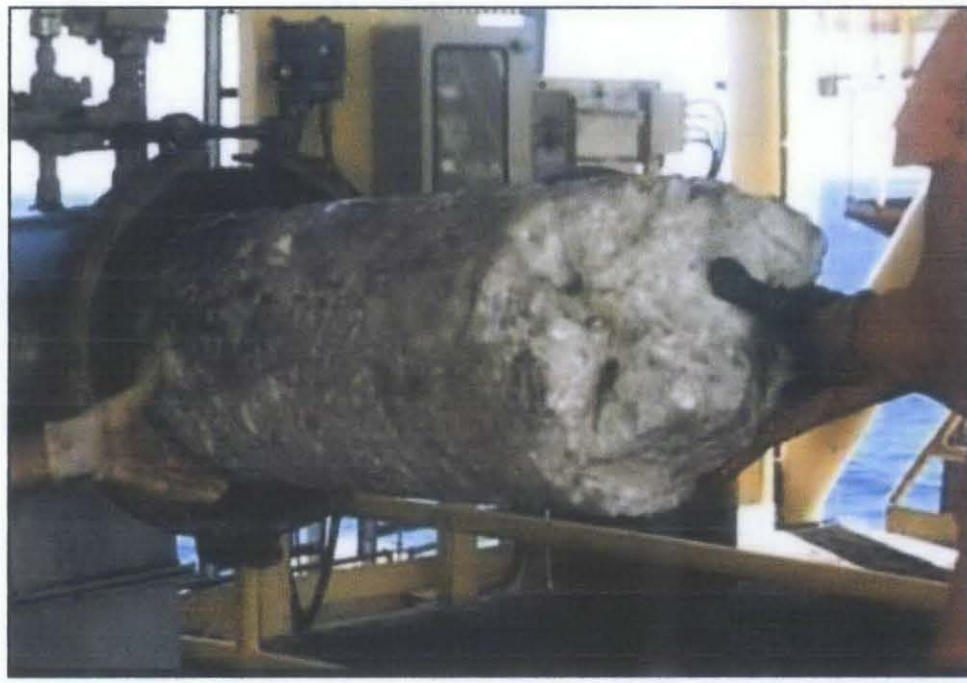

Figure 2: A Gas Hydrate Plug Formed in a Subsea Hydrocarbon Pipeline. Picture courtesy of Petrobras (Brazil).

2.6: Other Water Removal Techniques

2.6.1: Dehydration Using TEG

The most common and economic method to remove water vapour from natural gas is by absorption using triethylene glycol (TEG). Natural gas containing water is fed through the absorber where TEG will absorb the water. The glycol is then fed to a flash vessel to remove hydrocarbon and is then regenerated (Karimi, A. & Abadi, M.A., 2006).

The hydroxyl group in glycols are the reason why they are good water absorbers. This is because they form similar associations with water. However, the disadvantage of glycol dehydration is that they release harmful compounds such as BTX and VOC's into the atmosphere.

2.6.2: Dry – Bed Dehydration

Dry – bed dehydration uses solid reagent to remove water. Adsorbents such as silica gel, molecular sieve and activated alumina are used. Besides having a high capacity for water removal, these materials also have a large internal surface area.

However, the disadvantage of this method is that the adsorbents become saturated quickly and needs to be regenerated. Regeneration is usually done by heating; the water is vaporized from the adsorbents. Dry – bed dehydration requires two parallel vessels in operation; one will be adsorbing while the other is being regenerated.

CHAPTER 3: METHODOLOGY

Before starting any modelling work, extensive background research must be done. This project is divided into two semesters, where the first semester involves conducting literature review and planning the project methodology. The following figure lists the steps done in the first part of this project.

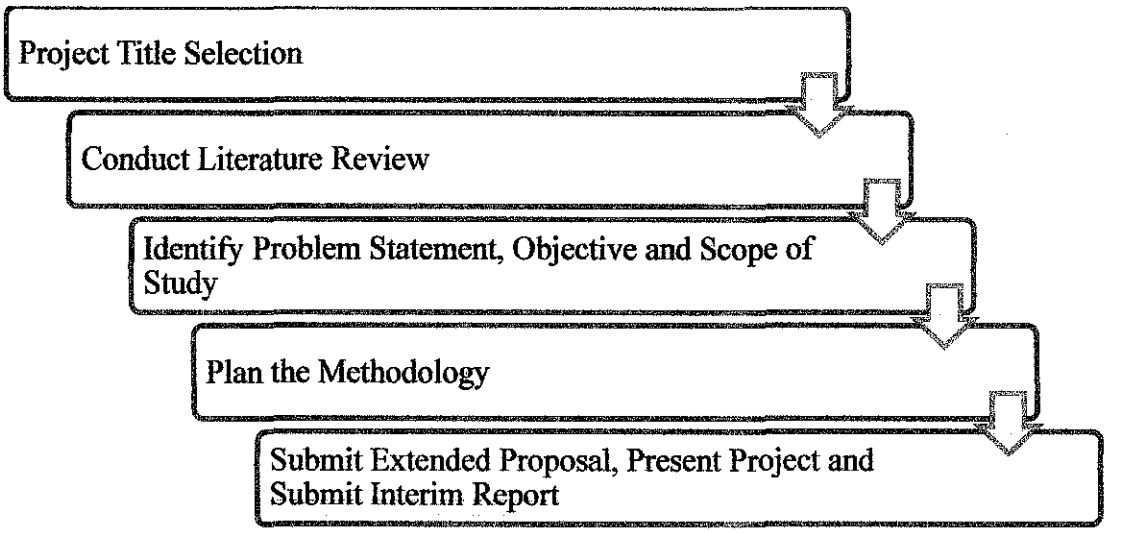

Figure 3: Work Sequence for Final Year Project I

The modelling of the nozzle is done in the second part of the project. Figure 4 lists down the work involved.

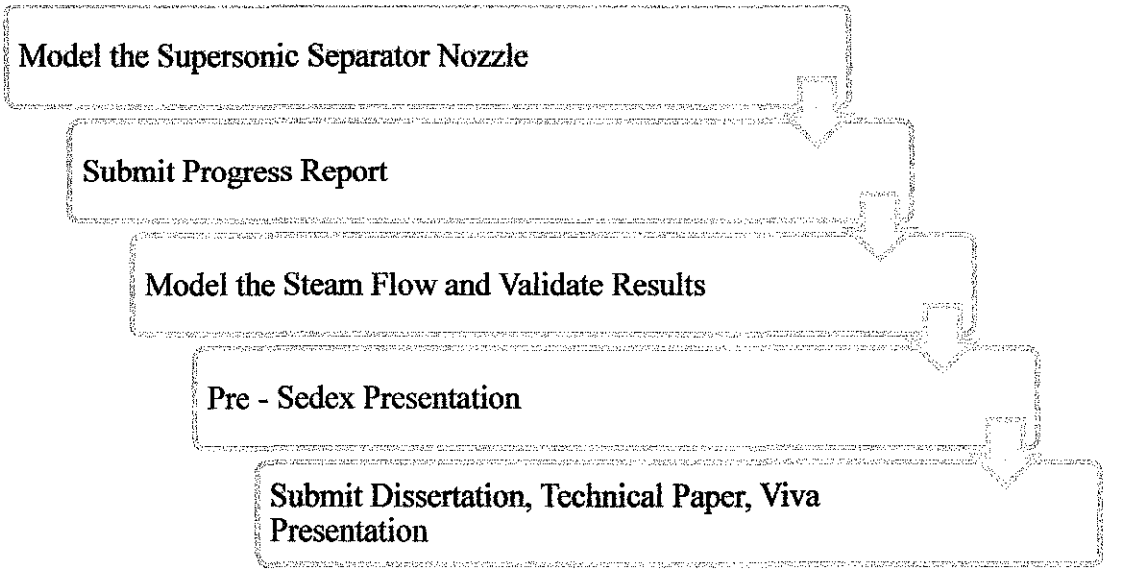

Figure 4: Work Sequence for Final Year Project II

In order to study the hydrodynamics of this supersonic gas separator, a modelling of the laval nozzle will be done. This study will be based on the findings of Yang, Y. & Shen, S. (2009), who modelled the flow of water vapour through a converging-diverging nozzle. The validation of this project will also be based on this paper.

The software ANSYS 12 allows user to draw the nozzle geometry and mesh it directly before setting up the physical properties. The following are the description of the steps involved in modelling the nozzle.

3.1: Modelling the Nozzle

3.1.1: Nozzle Geometry

The nozzle is drawn using DesignModeler in ANSYS 12 Workbench. Due to time constraints and other limitations, this study will only be focusing on the area near the nozzle's throat. This is because the throat is where the rapid velocity increase occur which results in a rapid pressure and temperature drop. The dimension of the nozzle for the purpose of this study will be the same as the one used by Yang, Y. & Shen, S. (2009). The table below shows the nozzle dimensions.

Table 2: Geometry of the Converging-Diverging Nozzle

Position	1	2	3	4
X (m)	-0.25	-0.2	0	0.5
Y (m)	0.05635	0.05635	0.05	0.072

The throat is at position 0. Points are plotted from the coordinates given above, and edges and a surface is generated. The figure below is the resulting geometry drawn from the dimension given above. The geometry is a symmetric drawing of the nozzle.

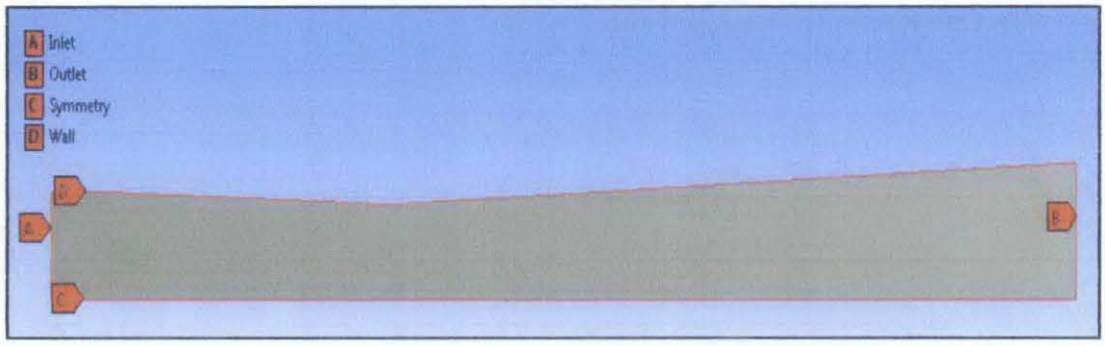

Figure 5: Front View of the Converging-Diverging Nozzle Geometry

3.1.2: Mesh

After the geometry is ready, it must be meshed before setting up the physical properties in FLUENT. The purpose of meshing is to divide the geometry into smaller cells or elements to ease the calculation.

These cells will affect the simulation results as a coarse mesh with fewer cells will give an inaccurate result, whereas a fine mesh with a large number of cells will yield better result.

For the purpose of this study, the mesh is designed to have more cells at critical areas such as near the wall. The figure and table below describes how the mesh is designed to achieve this.

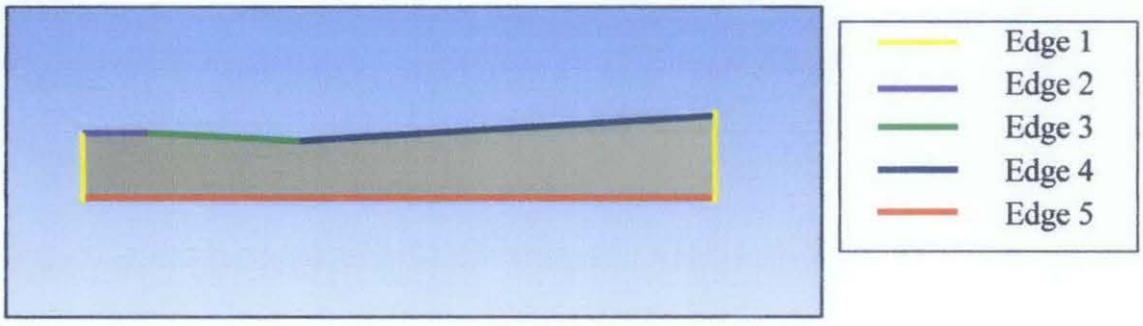

Figure 6: Edge Sizing for Mesh Generation

The edges of the geometry are divided into a certain number of divisions which are shown in the table below. Certain edges are biased to achieve smaller cells at certain areas.

Table 3: Edge Sizing Specification for Meshing

Edge	**1**	**2**	**3**	**4**	**5**	**No. of Elements**
No. of Division	30	12	40	100	200	5370

The resulting mesh is displayed in the figure below. It is quadrilateral which means that it has four sides.

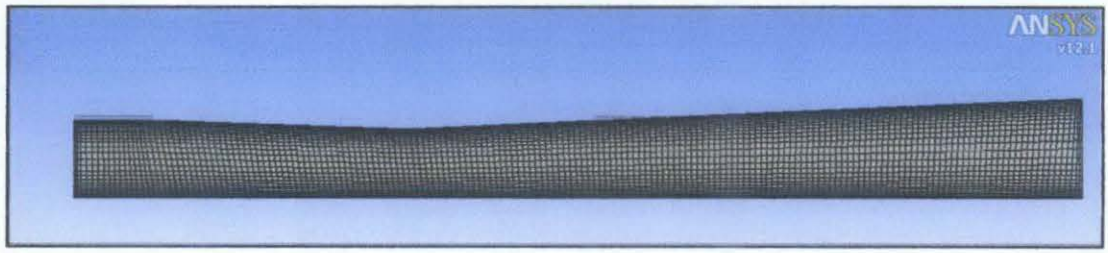

Figure 7: Meshing Results

The mesh elements must be of equal size to give a good result. Besides that, the cells must not be skewed. This means that the cells are square shaped, as shown in the close-up of the mesh below.

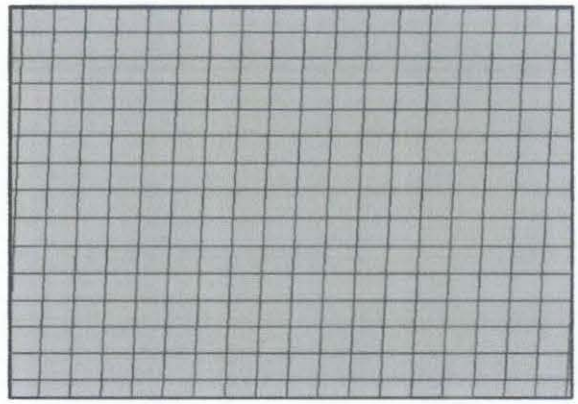

Figure 8: Close-Up View of Mesh Elements

3.1.3: FLUENT

The physical properties of the fluid flowing through the nozzle are modelled in FLUENT. In this study, the solver used is Pressure-Based in a 2-D axisymmetric space.

Water vapour flow is modelled using the K – Epsilon viscous model. The boundary condition is taken to be the same as Yang, Y. & Shen, S. (2009) and is as follows;

1) Inlet: Total Pressure is 25,000 Pa and Total Temperature is 354.6 K. It has a turbulent intensity of 5% and an eddy length scale that is 0.075 of the nozzle inlet diameter.
2) Symmetry: The flow is symmetrical to the nozzle centreline.
3) Wall: The wall is a no-slip adiabatic wall.
4) Outlet: Supersonic outflow conditions; all flow parameters are extrapolated from the interior domain.

The solution is initialized according to the settings shown below, and the number of iteration is set at 500. Calculation is solved when it has converged.

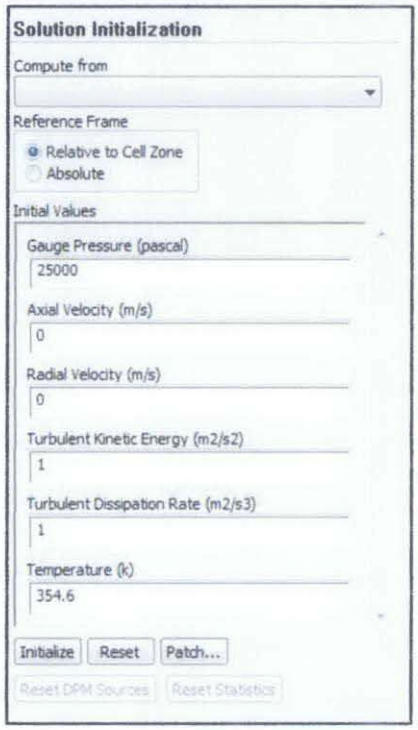

Figure 9: Solution Initialization Settings

3.2: Grid Size Optimization

As mentioned before, a too coarse mesh will result in an inaccurate result. However, a mesh that is too fine will take a long time to solve. Therefore, the grid size must be optimized in order to get the most suitable mesh.

The grid is optimized by increasing the number of division for each edges and the generated mesh will be solved with the same setting in FLUENT. A velocity graph will be plotted and compared to identify the optimized grid. The table below describes the number of division of each edges and the number of elements for each mesh.

Table 4: Grid Size Optimization Meshing Specifications

Mesh	Edge	1	2	3	4	5	Elements
1	Number of Divisions	30	12	40	100	200	5,370
2		60	20	80	200	400	21,420
3		90	30	120	300	600	47,340
4		120	40	160	400	800	84,000
5		150	50	200	500	850	120,600
6		180	60	240	600	900	162,540
7		240	80	320	800	1000	276,720
8		270	90	360	900	1000	315,630

Figure 10: Partial View of Mesh 7

3.3: Manipulated Variable – Throat Diameter

The throat diameter was manipulated to study its' effect on static pressure and Mach number profile along the nozzle centreline. This was done by changing the geometry of the nozzle while keeping other settings constant. A static pressure and Mach number distribution was then plotted. Table 5 below shows the different throat diameters used while Figure 11 displays the points involved.

Table 5: Different Throat Diameters

Point 1	Point 2	Difference
0.05635	0.05635	0
	0.053175	0.003175
	0.05	0.00635
	0.046825	0.009525
	0.04	0.01635

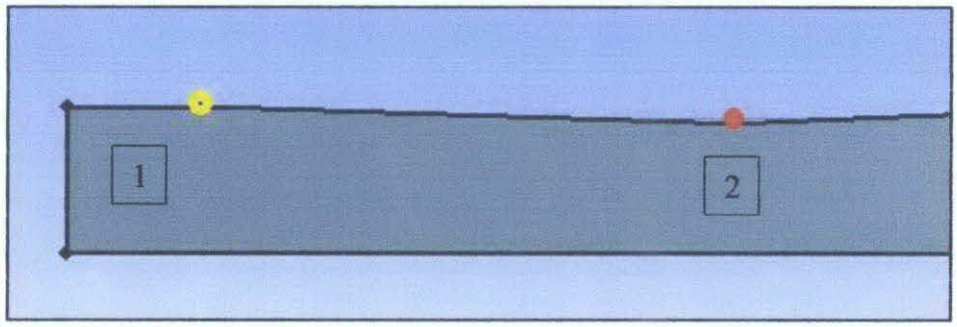

Figure 11: Points 1 and 2 on Geometry

3.4: Manipulated Variable – Inlet Pressure

Inlet pressure was also manipulated to study its' effect on static pressure and Mach number profile. This is done by changing the pressure value at the inlet boundary condition. Table 6 displays the different pressures used to achieve this.

Table 6: Different Inlet Pressures

Inlet Pressure
20 kPa
25 kPa
30 kPa
35 kPa
10 MPa

CHAPTER 4: RESULTS & DISCUSSION

4.1: Grid Size Optimization

The graph of velocity along the nozzle symmetry for different meshes is depicted below. Mesh 7 and 8 overlaps; this is because even though mesh 8 is finer than mesh 7, it will not yield a different result. Thus mesh 7 is the optimized grid.

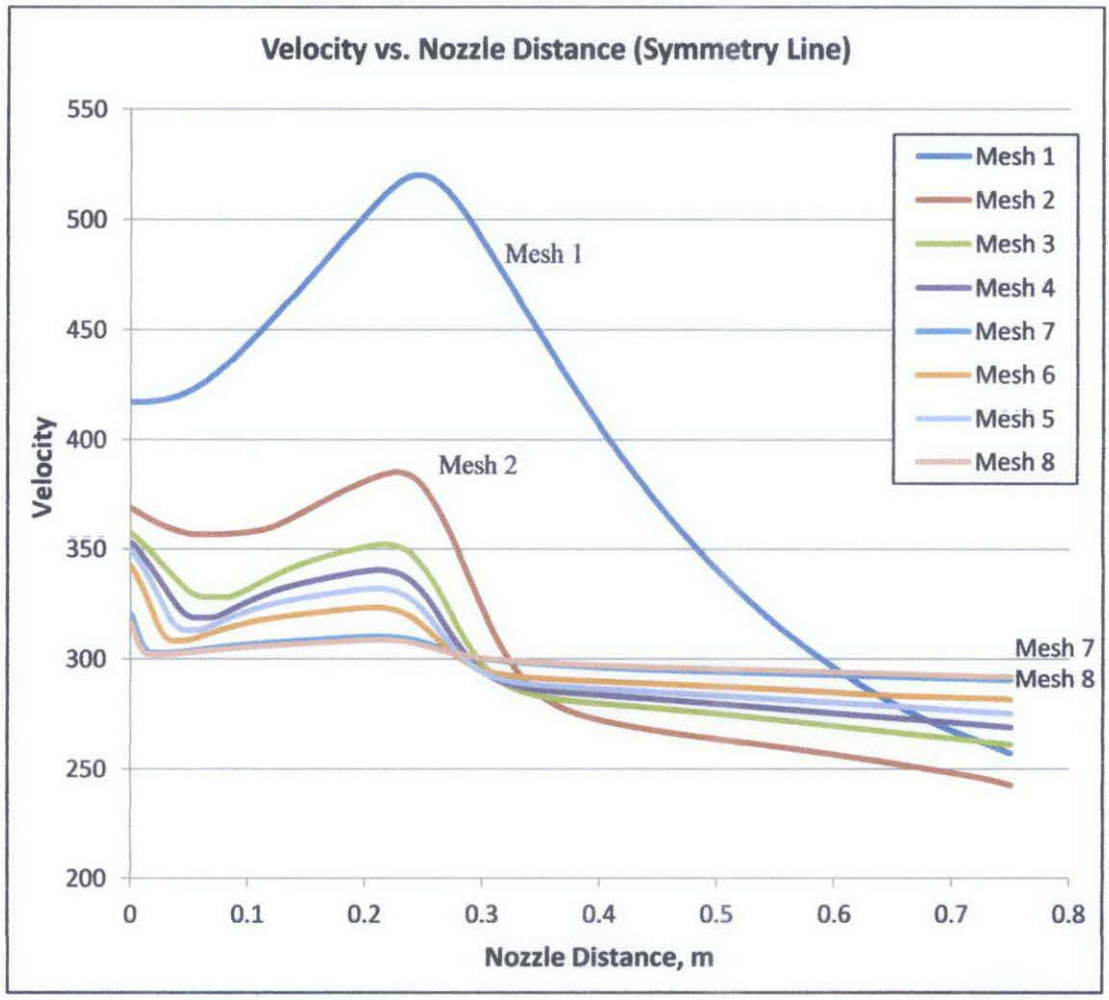

Figure 12: Velocity Profile for Different Mesh

Now that the optimized mesh has been obtained, the next step is to model the hydrodynamics of the fluid. The nozzle will be modelled with the same properties as what Yang, Y. & Shen, S. (2009) has proposed in order to validate the result.

4.2: Water Vapour Hydrodynamics Simulation

4.2.1: Static Pressure Profile

As described in the methodology section, the nozzle is modelled with the boundary conditions specified by Yang, Y. & Shen, S. (2009). The figure below shows that the result simulated is almost similar to the result obtained by Yang, Y. & Shen, S. (2009), who also compared their simulation to the results of the experiment by Moore et al. (1973).

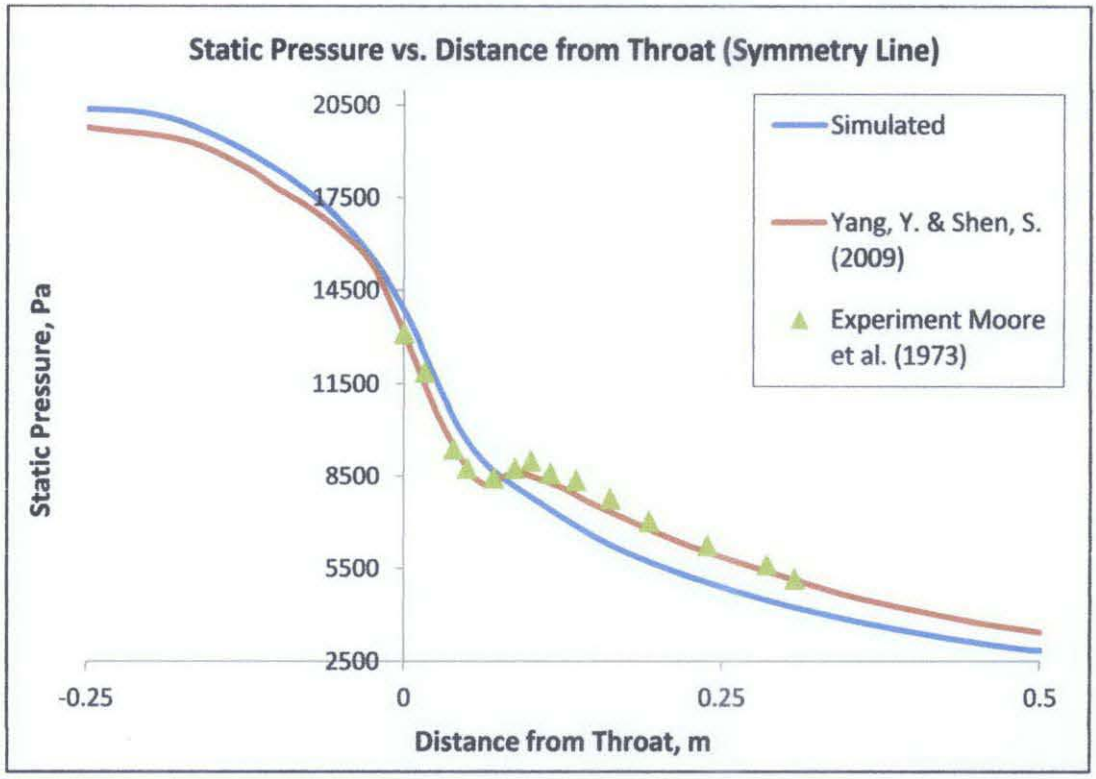

Figure 13: Comparison between Simulation Result and Published Result by Yang, Y. & Shen, S. (2009)

As the water vapour enters the nozzle inlet, it undergoes expansion that causes the gradual pressure drop. When the vapour reaches the converging throat, the smaller opening accelerates the flow rate and this induces a rapid pressure and temperature drop. The diverging body of the nozzle expands the fluid, thus resulting in the continuing pressure drop.

4.2.2: Mach Number Profile

From the simulation done, we can also plot the Mach number profile along the nozzle symmetry. Figure 14 below depicts this.

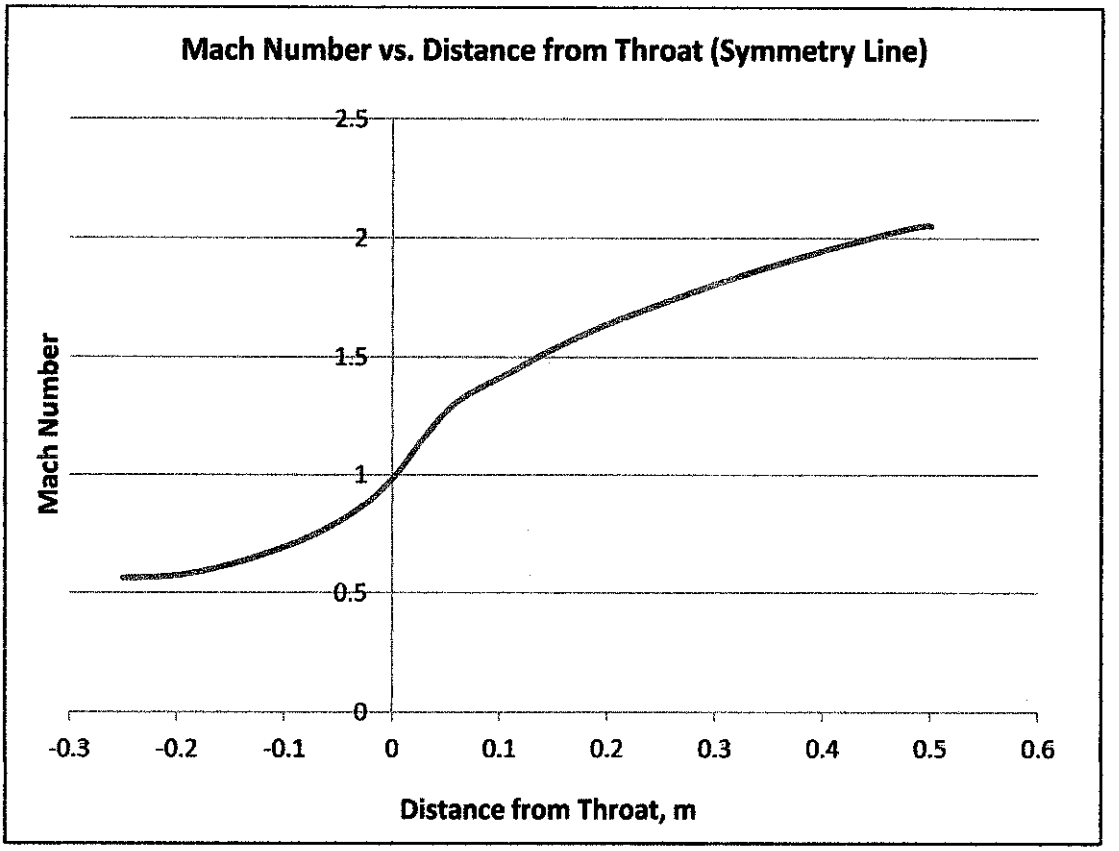

Figure 14: Mach Number Profile Along Nozzle Symmetry

The flow between the inlet and throat has a Mach number that is less than one. This indicates that the flow is subsonic, which is less than the speed of sound. At the throat, the decreasing area caused the velocity to increase. The Mach number is equal to 1 at the throat.

After the throat, at the diverging section the Mach number keeps increasing. This is due to the fact that when the flow is supersonic, the relationship between flow area and speed is reversed to that at subsonic flow. This means that expanding the flow area actually increases the speed.

This phenomenon can be described by the relationship between area and velocity (Emami, M. R., 2008), as shown below. It is the design basis of the converging – diverging nozzle.

$$\left[\frac{A}{A^*}\right]^2 = \frac{1}{M^2}\left[\frac{2}{\gamma+1}\left(1+\frac{\gamma-1}{2}M^2\right)\right]^{\frac{\gamma+1}{\gamma-1}}$$

From the equation above, it is found that Mach number, M is a function of A/A*, and A/A* $\geq$ 1, where A/A* is the ratio of the nozzle cross sectional area to the smallest cross sectional area (throat). Thus,

a) For subsonic flow, M increases as A/A* decreases, i.e. the nozzle converges
b) For M = 1, A/A* = 1, the flow is sonic
c) For supersonic situations, M increases as A/A* increases, i.e. the nozzle diverges

The conclusion by (c) can be further explained by the equation below (Emami, M. R., 2008);

$$\frac{dA}{A} = (M^2 - 1)\frac{dV}{V}$$

Where $\frac{dA}{dV}$ = derivative of area with respect to velocity

A = nozzle cross sectional area

V = fluid velocity

M = Mach number

It is evident that velocity increases when there is an area enlargement. Furthermore, if dA/A = 0, the nozzle has a minimum area, i.e. the throat and the Mach number at that location is 1.

4.3: Manipulated Variable – Throat Diameter

4.3.1: Static Pressure Profile

The throat diameter was manipulated to study its' effect on the static pressure profile along the nozzle symmetry line. Figure 15 displays the result.

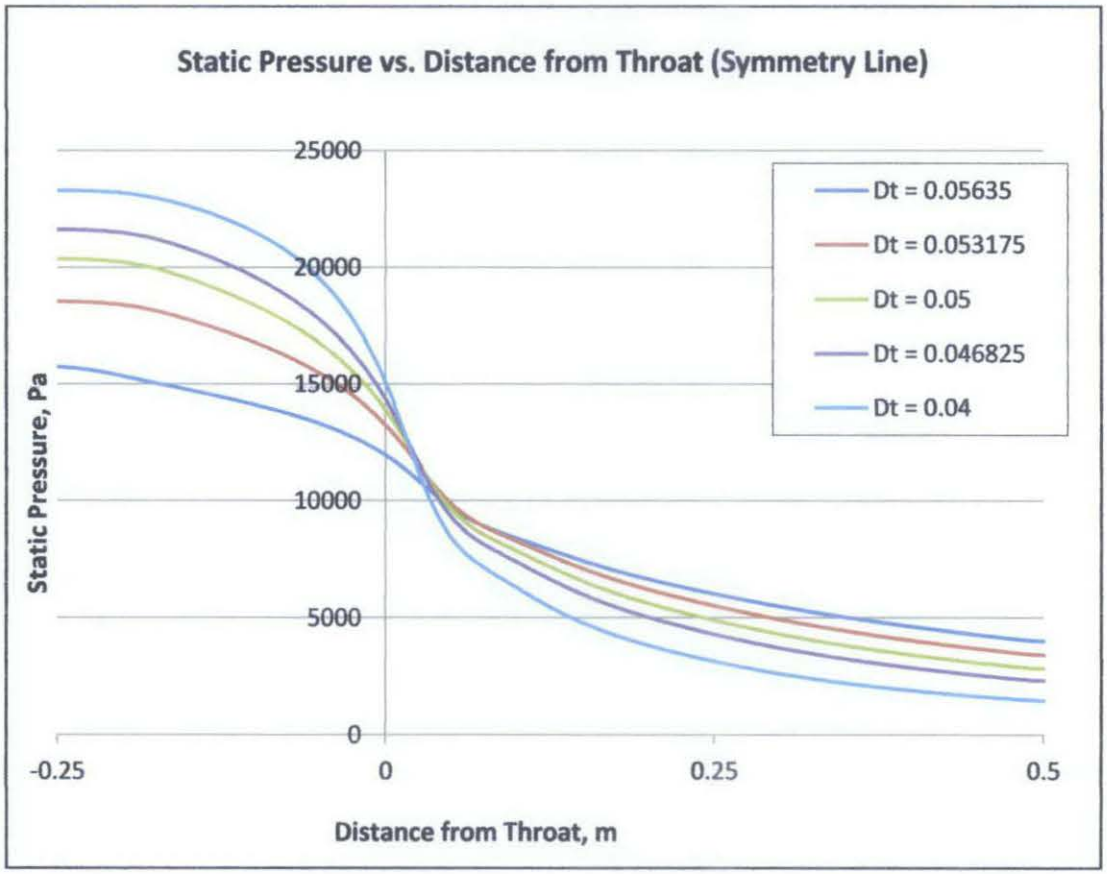

Figure 15: Effect of Nozzle Throat Diameter on the Static Pressure Profile

From the plot above, it is observed that as nozzle throat becomes smaller, the static pressure drop becomes larger. This is because the sudden decrease in cross sectional area causes the flow to accelerate and lose pressure. The nozzle with throat diameter of 0.05635 m has less pressure drop because there is no constriction to the flow, i.e. the diameter is the same as the inlet diameter.

4.3.2: Mach Number Profile

The Mach number profile was also plotted for various throat diameters to observe its' relationship. Figure 16 below displays the result.

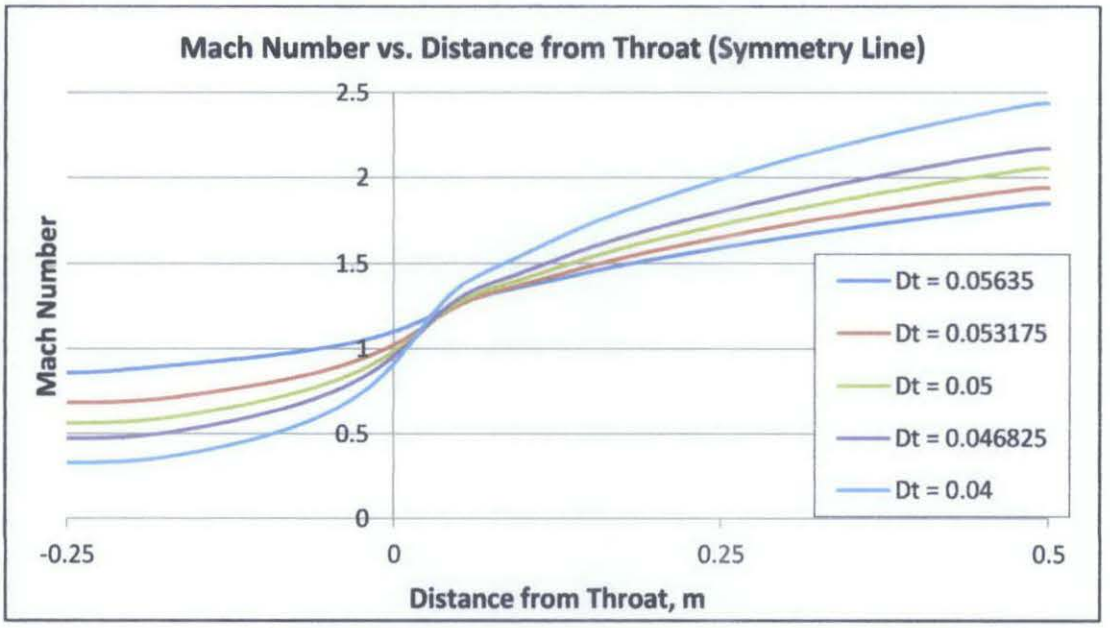

Figure 16: Effect of Nozzle Throat Diameter on Mach Number Profile

The figure above supports the claim that when static pressure drops, the velocity of the flow increases. It is observed that all flow achieves supersonic velocity. However, the throat diameter of 0.05635 m attains sonic speed before the throat. This is clearly not in accordance to the working mechanism of a de laval nozzle. Table 6 below shows the Mach number near the throat, the full data is attached at the appendix. The nozzle with throat diameter of 0.05 m has the closest Mach number equivalent to 1, while the other smaller diameters have lower Mach numbers.

Table 7: Mach Number Near the Throat for Different Geometries

Diameter	x	y
0.05635 m	0.00160256	1.10596
0.053175 m		1.03081
0.05 m		0.99234
0.046825 m		0.965981
0.04 m		0.926868

4.4: Manipulated Variable – Inlet Pressure

4.4.1: Static Pressure Profile

The inlet boundary condition was manipulated to study the effect of different inlet pressure on the static pressure profile along the nozzle centerline. Figure 17 below shows the result.

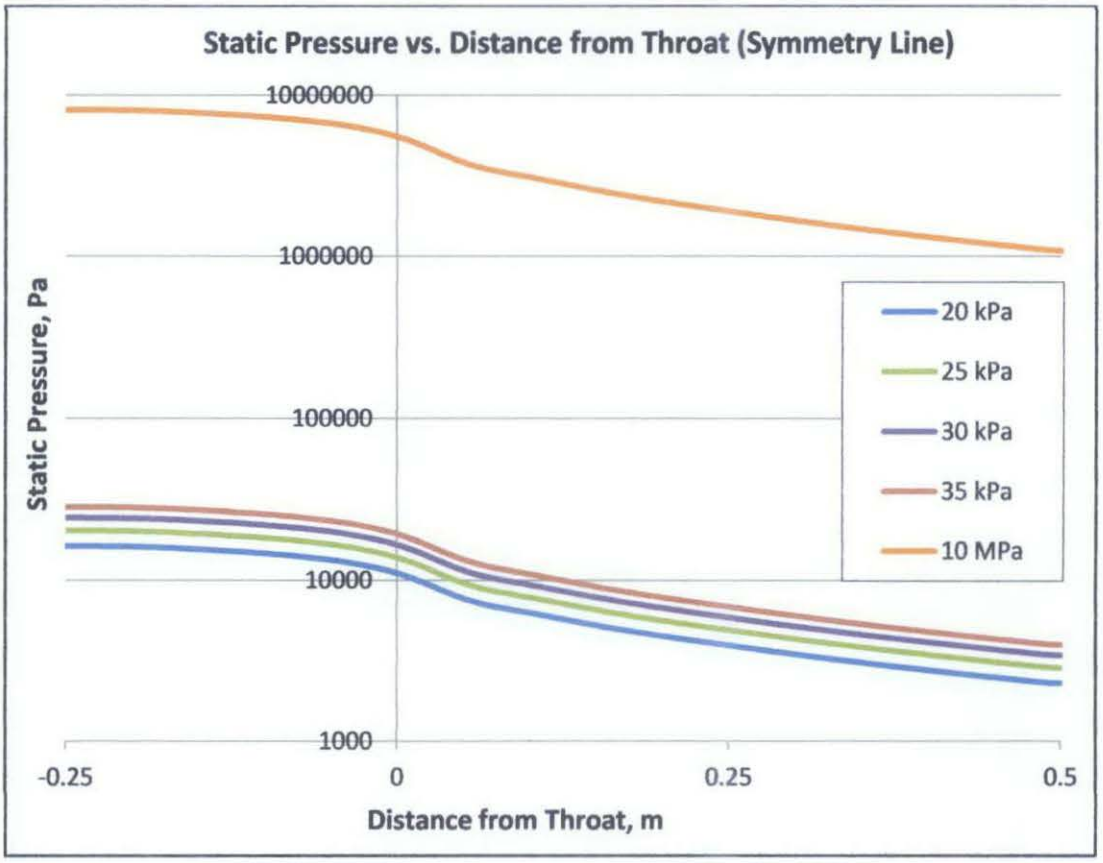

Figure 17: Effect of Inlet Pressure on Static Pressure Profile

It is observed that for different inlet pressure, the static pressure profile are similar, but with different magnitudes. This proves that inlet pressure does not affect the pressure drop along the nozzle. A high inlet pressure would not give a larger pressure drop because it is flowing through the same nozzle with the same dimensions as other lower inlet pressures. Thus, the pressure drop along the nozzle depends on the nozzle cross sectional area, and not the inlet pressure.

4.4.2: Mach Number Profile

Besides static pressure, the Mach number profile along the nozzle centerline was plotted for each different inlet pressure. Figure 18 below displays the result.

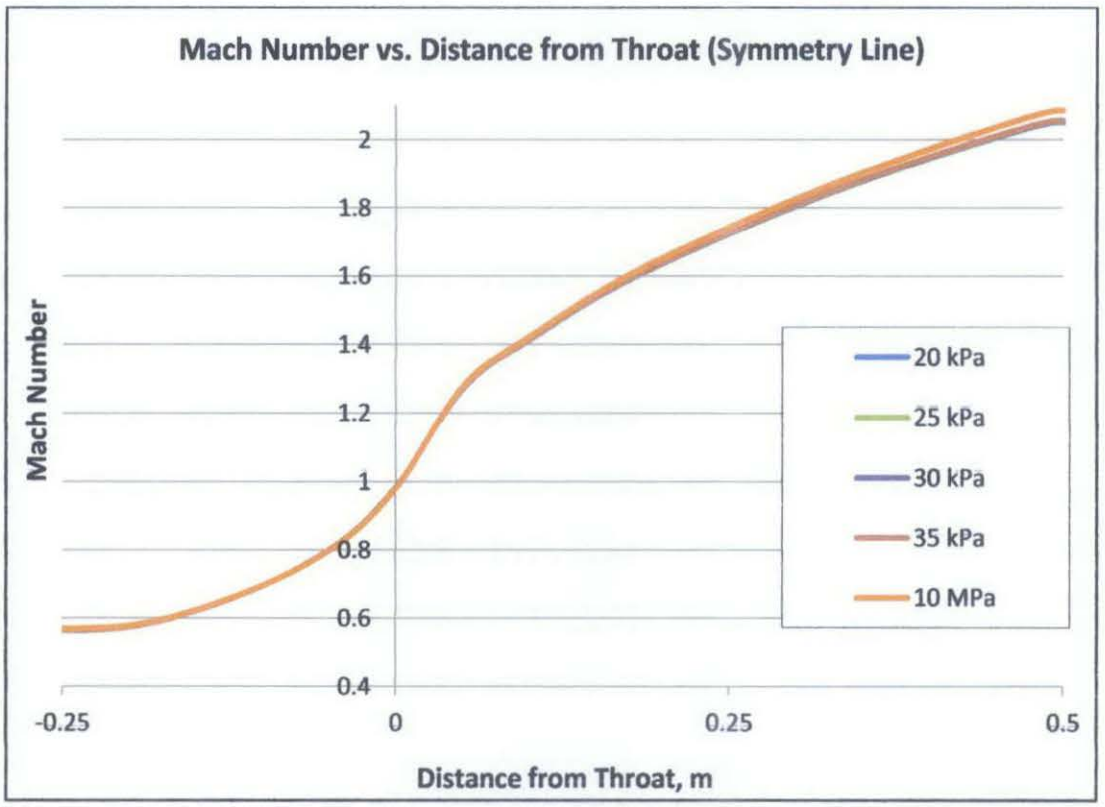

Figure 18: Effect of Inlet Pressure on Mach Number Profile

The different inlet pressure values does not affect the Mach number profile along the nozzle. As figure 18 displays, the Mach number overlaps each other except for the 10 MPa inlet pressure, whose Mach number has a small deviation. However, the deviation is very small, thus negligible.

CHAPTER 5: CONCLUSION & RECOMMENDATION

The objectives of this project have been achieved, one of which is to model the hydrodynamics i.e. pressure and velocity profile for water dehydration in a supersonic nozzle. This was done by drawing and meshing the nozzle using ANSYS 12. The physical setup in FLUENT was also done.

The second objective of this study, which was to validate the model, has also been achieved. The simulated result has been compared with the experimental result published in the paper of Yang, Y. & Shen, S. (2009) and it was found to be similar.

The last objective was to study the effect of manipulating the throat diameter and inlet pressure to the static pressure and Mach number profile. It was found that nozzle throat diameter has an effect on static pressure and Mach number; the larger diameter will have a larger pressure drop and higher Mach number. On the other hand, inlet pressure does not have any significant effect on static pressure and Mach number.

For the purpose of future work, below are some recommendations for improvement;

1) Hydrodynamics model is combined with thermodynamics and nucleation theory for a complete water dehydration model.
2) Simulation can be done using a multiphase model to be compared with the single phase water vapour simulation. Components involved could be water vapour – water liquid or water vapour – natural gas.
3) Conduct experiment to further validate modelling results.
4) The same methodology used in this project to simulate water removal can also be used to simulate the removal of carbon dioxide gas from natural gas. This is beneficial as the current application for supersonic gas separator is carbon dioxide removal.

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APPENDIX I: PROJECT TIMELINE FOR FYP I

NO.	ACTIVITY / WEEK	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1.	Selection of Project Title	■	■													
2.	Preliminary Research Work		■	■	■	■										
3.	Submission of Extended Proposal						■									
4.	Preparation for Oral Proposal Defence							■								
5.	Oral Proposal Defence Presentation									■						
6.	Detailed Literature Review									■	■	■	■	■		
7.	Learn Modelling Software (GAMBIT, FLUENT)			■	■	■	■	■		■	■	■	■	■	■	■
8.	Preparation of Interim Report			■	■	■	■	■		■	■	■	■	■		
9.	Submission of Interim Draft Report														■	
10.	Submission of Interim Final Report															■

APPENDIX II: PROJECT TIMELINE FOR FYP II

NO.	ACTIVITY / WEEK	1	2	3	4	5	6	7		8	9	10	11	12	13	14	15
1.	Project Work Continues • Model the Supersonic Separator Nozzle																
2.	Submission of Progress Report																
3.	Project Work Continues • Model the Hydrodynamics of Steam Flow • Validate Results • Model the Hydrodynamics of Natural Gas and Carbon Dioxide Flow																
4.	Pre-SEDEX																
5.	Submission of Draft Report																
6.	Submission of Dissertation (Soft Bound)																
7.	Submission of Technical Paper																
8.	Oral Presentation																
9.	Submission of Project Dissertation (Hard Bound)																

APPENDIX III: GRID SIZE OPTIMIZATION DATA (MESH 1 - 4)

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
0	417.296	0	368.8	0	357.177	0	352.796
0.001063	417.288	0.000469	368.76	0.000473	357.12	0.000471	352.733
0.002378	417.273	0.001065	368.636	0.001074	356.939	0.00107	352.532
0.005258	417.271	0.001835	368.423	0.001847	356.634	0.001837	352.188
0.009511	417.312	0.002816	368.109	0.002818	356.193	0.002782	351.693
0.013764	417.415	0.004052	367.686	0.004	355.62	0.003835	351.096
0.018017	417.594	0.005599	367.147	0.005355	354.945	0.004909	350.457
0.02227	417.858	0.007451	366.509	0.006786	354.224	0.005985	349.793
0.026522	418.214	0.009534	365.814	0.008225	353.494	0.007061	349.107
0.030775	418.672	0.011678	365.126	0.009663	352.757	0.008137	348.402
0.035028	419.243	0.013821	364.465	0.011102	352.012	0.009213	347.679
0.039281	419.939	0.015965	363.828	0.01254	351.257	0.010289	346.94
0.043534	420.767	0.018109	363.215	0.013978	350.491	0.011365	346.186
0.047786	421.733	0.020253	362.627	0.015417	349.717	0.012441	345.418
0.052039	422.84	0.022396	362.063	0.016855	348.933	0.013517	344.638
0.056292	424.087	0.02454	361.52	0.018294	348.141	0.014593	343.846
0.060545	425.482	0.026684	360.997	0.019732	347.341	0.015669	343.045
0.064797	427.031	0.028828	360.497	0.021171	346.535	0.016745	342.234
0.06905	428.715	0.030971	360.026	0.022609	345.721	0.017821	341.416
0.073303	430.517	0.033115	359.591	0.024048	344.902	0.018897	340.59
0.077556	432.424	0.035259	359.191	0.025486	344.077	0.019973	339.758
0.081809	434.421	0.037403	358.817	0.026925	343.251	0.021049	338.921
0.086061	436.497	0.039546	358.464	0.028363	342.425	0.022125	338.08
0.090314	438.639	0.04169	358.128	0.029802	341.603	0.023201	337.235
0.094567	440.839	0.043834	357.809	0.03124	340.783	0.024277	336.386
0.09882	443.089	0.045978	357.504	0.032679	339.964	0.025353	335.532
0.103073	445.38	0.048121	357.217	0.034117	339.145	0.026429	334.673
0.107325	447.709	0.050265	356.974	0.035556	338.325	0.027505	333.809
0.111578	450.069	0.052409	356.812	0.036994	337.505	0.028581	332.938
0.115831	452.458	0.054553	356.732	0.038432	336.687	0.029657	332.063
0.120084	454.871	0.056697	356.695	0.039871	335.873	0.030733	331.185
0.124337	457.305	0.05884	356.677	0.041309	335.069	0.031809	330.307
0.128589	459.759	0.060984	356.671	0.042748	334.283	0.032885	329.436
0.132842	462.229	0.063128	356.67	0.044186	333.525	0.033961	328.575
0.137095	464.715	0.065272	356.672	0.045625	332.809	0.035037	327.731
0.141348	467.213	0.067415	356.679	0.047063	332.145	0.036113	326.908
0.145601	469.723	0.069559	356.69	0.048502	331.538	0.037189	326.105
0.149853	472.244	0.071703	356.707	0.04994	330.987	0.038265	325.323
0.154106	474.773	0.073847	356.731	0.051379	330.484	0.039341	324.564
0.158359	477.309	0.07599	356.762	0.052817	330.019	0.040417	323.833
0.162612	479.852	0.078134	356.801	0.054256	329.59	0.041493	323.137

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
0.166865	482.401	0.080278	356.849	0.055694	329.208	0.042569	322.486
0.171117	484.953	0.082422	356.907	0.057133	328.891	0.043645	321.89
0.17537	487.507	0.084565	356.973	0.058571	328.659	0.044721	321.36
0.179623	490.061	0.086709	357.05	0.06001	328.513	0.045797	320.899
0.183876	492.612	0.088853	357.137	0.061448	328.43	0.046873	320.502
0.188129	495.156	0.090997	357.234	0.062886	328.38	0.047949	320.16
0.192381	497.687	0.09314	357.341	0.064325	328.347	0.049025	319.86
0.196634	500.198	0.095284	357.46	0.065763	328.325	0.050101	319.596
0.200887	502.679	0.097428	357.588	0.067202	328.311	0.051177	319.374
0.20514	505.116	0.099572	357.727	0.06864	328.303	0.052253	319.204
0.209393	507.49	0.101715	357.876	0.070079	328.299	0.053328	319.091
0.213645	509.779	0.103859	358.035	0.071517	328.297	0.054404	319.026
0.217898	511.954	0.106003	358.205	0.072956	328.296	0.05548	318.989
0.222151	513.979	0.108147	358.388	0.074394	328.297	0.056556	318.966
0.226404	515.814	0.11029	358.592	0.075833	328.3	0.057632	318.951
0.230656	517.414	0.112434	358.83	0.077271	328.305	0.058708	318.942
0.234909	518.717	0.114578	359.116	0.07871	328.315	0.059784	318.936
0.239162	519.623	0.116722	359.453	0.080148	328.33	0.06086	318.933
0.243415	520.071	0.118865	359.834	0.081587	328.356	0.061936	318.932
0.247668	520.099	0.121009	360.25	0.083025	328.41	0.063012	318.931
0.25192	519.711	0.123153	360.697	0.084464	328.531	0.064088	318.932
0.256173	518.838	0.125297	361.17	0.085902	328.731	0.065164	318.933
0.260426	517.476	0.12744	361.666	0.087341	328.983	0.06624	318.937
0.264679	515.678	0.129584	362.182	0.088779	329.263	0.067316	318.944
0.268932	513.497	0.131728	362.717	0.090217	329.559	0.068392	318.96
0.273184	510.991	0.133872	363.267	0.091656	329.865	0.069468	319.006
0.277437	508.214	0.136015	363.83	0.093094	330.183	0.070544	319.102
0.28169	505.217	0.138159	364.405	0.094533	330.514	0.07162	319.241
0.285943	502.045	0.140303	364.989	0.095971	330.859	0.072696	319.41
0.290196	498.735	0.142447	365.582	0.09741	331.219	0.073772	319.603
0.294448	495.318	0.14459	366.181	0.098848	331.59	0.074848	319.821
0.298701	491.82	0.146734	366.786	0.100287	331.97	0.075924	320.062
0.302954	488.259	0.148878	367.395	0.101725	332.356	0.077	320.321
0.307207	484.651	0.151022	368.006	0.103164	332.747	0.078076	320.591
0.31146	481.008	0.153165	368.62	0.104602	333.139	0.079152	320.867
0.315712	477.341	0.155309	369.234	0.106041	333.534	0.080228	321.146
0.319965	473.656	0.157453	369.849	0.107479	333.928	0.081304	321.428
0.324218	469.96	0.159597	370.463	0.108918	334.322	0.08238	321.711
0.328471	466.26	0.16174	371.076	0.110356	334.716	0.083456	321.995
0.332724	462.558	0.163884	371.688	0.111795	335.108	0.084532	322.28
0.336976	458.86	0.166028	372.297	0.113233	335.499	0.085608	322.565
0.341229	455.17	0.168172	372.903	0.114671	335.888	0.086684	322.85
0.345482	451.49	0.170315	373.506	0.11611	336.275	0.08776	323.135

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
0.349735	447.824	0.172459	374.105	0.117548	336.659	0.088836	323.418
0.353987	444.174	0.174603	374.7	0.118987	337.04	0.089912	323.701
0.35824	440.544	0.176747	375.291	0.120425	337.419	0.090988	323.981
0.362493	436.936	0.17889	375.876	0.121864	337.794	0.092064	324.26
0.366746	433.353	0.181034	376.455	0.123302	338.165	0.09314	324.537
0.370999	429.796	0.183178	377.028	0.124741	338.533	0.094216	324.812
0.375251	426.269	0.185322	377.594	0.126179	338.896	0.095292	325.084
0.379504	422.772	0.187465	378.152	0.127618	339.255	0.096368	325.354
0.383757	419.306	0.189609	378.702	0.129056	339.608	0.097444	325.621
0.38801	415.873	0.191753	379.241	0.130495	339.957	0.09852	325.886
0.392263	412.471	0.193897	379.77	0.131933	340.3	0.099596	326.148
0.396515	409.104	0.19604	380.287	0.133372	340.637	0.100672	326.408
0.400768	405.774	0.198184	380.79	0.13481	340.967	0.101748	326.665
0.405021	402.484	0.200328	381.278	0.136249	341.287	0.102824	326.92
0.409274	399.235	0.202472	381.748	0.137687	341.596	0.1039	327.172
0.413527	396.03	0.204615	382.2	0.139125	341.893	0.104976	327.422
0.417779	392.87	0.206759	382.631	0.140564	342.181	0.106052	327.669
0.422032	389.756	0.208903	383.041	0.142002	342.463	0.107128	327.913
0.426285	386.69	0.211047	383.427	0.143441	342.741	0.108204	328.155
0.430538	383.671	0.21319	383.79	0.144879	343.015	0.109279	328.394
0.434791	380.7	0.215334	384.13	0.146318	343.286	0.110355	328.631
0.439043	377.776	0.217478	384.444	0.147756	343.552	0.111431	328.864
0.443296	374.898	0.219622	384.734	0.149195	343.815	0.112507	329.095
0.447549	372.066	0.221765	384.996	0.150633	344.073	0.113583	329.322
0.451802	369.279	0.223909	385.213	0.152072	344.329	0.114659	329.547
0.456054	366.536	0.226053	385.335	0.15351	344.581	0.115735	329.769
0.460307	363.837	0.228197	385.306	0.154949	344.829	0.116811	329.987
0.46456	361.181	0.23034	385.124	0.156387	345.074	0.117887	330.202
0.468813	358.568	0.232484	384.84	0.157826	345.316	0.118963	330.415
0.473066	355.997	0.234628	384.479	0.159264	345.555	0.120039	330.623
0.477318	353.467	0.236772	384.036	0.160703	345.791	0.121115	330.829
0.481571	350.979	0.238915	383.494	0.162141	346.025	0.122191	331.031
0.485824	348.531	0.241059	382.823	0.16358	346.255	0.123267	331.229
0.490077	346.123	0.243203	381.989	0.165018	346.482	0.124343	331.422
0.49433	343.754	0.245347	380.965	0.166456	346.707	0.125419	331.611
0.498582	341.423	0.24749	379.76	0.167895	346.929	0.126495	331.794
0.502835	339.129	0.249634	378.398	0.169333	347.149	0.127571	331.969
0.507088	336.872	0.251778	376.909	0.170772	347.366	0.128647	332.138
0.511341	334.652	0.253922	375.305	0.17221	347.58	0.129723	332.302
0.515594	332.466	0.256065	373.586	0.173649	347.792	0.130799	332.463
0.519846	330.317	0.258209	371.757	0.175087	348.001	0.131875	332.622
0.524099	328.202	0.260353	369.821	0.176526	348.208	0.132951	332.779
0.528352	326.122	0.262497	367.784	0.177964	348.412	0.134027	332.934

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
0.532605	324.076	0.26464	365.65	0.179403	348.614	0.135103	333.086
0.536858	322.065	0.266784	363.425	0.180841	348.813	0.136179	333.237
0.54111	320.088	0.268928	361.115	0.18228	349.009	0.137255	333.386
0.545363	318.145	0.271072	358.727	0.183718	349.203	0.138331	333.533
0.549616	316.235	0.273215	356.27	0.185157	349.394	0.139407	333.677
0.553869	314.359	0.275359	353.753	0.186595	349.582	0.140483	333.821
0.558122	312.516	0.277503	351.183	0.188034	349.767	0.141559	333.962
0.562374	310.705	0.279647	348.57	0.189472	349.949	0.142635	334.102
0.566627	308.927	0.28179	345.924	0.19091	350.127	0.143711	334.24
0.57088	307.18	0.283934	343.254	0.192349	350.302	0.144787	334.377
0.575133	305.465	0.286078	340.568	0.193787	350.474	0.145863	334.513
0.579385	303.78	0.288222	337.875	0.195226	350.641	0.146939	334.647
0.583638	302.125	0.290365	335.186	0.196664	350.805	0.148015	334.78
0.587891	300.5	0.292509	332.507	0.198103	350.964	0.149091	334.911
0.592144	298.903	0.294653	329.848	0.199541	351.118	0.150167	335.041
0.596397	297.334	0.296797	327.216	0.20098	351.268	0.151243	335.17
0.600649	295.792	0.29894	324.62	0.202418	351.412	0.152319	335.298
0.604902	294.278	0.301084	322.066	0.203857	351.55	0.153395	335.425
0.609155	292.79	0.303228	319.561	0.205295	351.683	0.154471	335.551
0.613408	291.329	0.305372	317.112	0.206734	351.81	0.155547	335.676
0.617661	289.895	0.307515	314.724	0.208172	351.93	0.156623	335.8
0.621913	288.487	0.309659	312.403	0.209611	352.044	0.157699	335.923
0.626166	287.105	0.311803	310.153	0.211049	352.151	0.158775	336.045
0.630419	285.751	0.313947	307.98	0.212488	352.25	0.159851	336.167
0.634672	284.423	0.31609	305.887	0.213926	352.341	0.160927	336.287
0.638925	283.122	0.318234	303.877	0.215364	352.405	0.162003	336.407
0.643177	281.849	0.320378	301.953	0.216803	352.408	0.163079	336.525
0.64743	280.604	0.322522	300.115	0.218241	352.345	0.164155	336.643
0.651683	279.386	0.324665	298.363	0.21968	352.244	0.165231	336.76
0.655936	278.196	0.326809	296.696	0.221118	352.121	0.166307	336.877
0.660189	277.033	0.328953	295.115	0.222557	351.978	0.167383	336.992
0.664441	275.897	0.331097	293.615	0.223995	351.813	0.168458	337.107
0.668694	274.789	0.33324	292.196	0.225434	351.626	0.169534	337.221
0.672947	273.707	0.335384	290.855	0.226872	351.415	0.17061	337.334
0.6772	272.652	0.337528	289.588	0.228311	351.179	0.171686	337.447
0.681453	271.624	0.339672	288.393	0.229749	350.914	0.172762	337.558
0.685705	270.624	0.341815	287.267	0.231188	350.616	0.173838	337.669
0.689958	269.652	0.343959	286.207	0.232626	350.277	0.174914	337.779
0.694211	268.708	0.346103	285.208	0.234065	349.887	0.17599	337.888
0.698464	267.789	0.348247	284.269	0.235503	349.429	0.177066	337.997
0.702716	266.893	0.35039	283.386	0.236942	348.898	0.178142	338.104
0.706969	266.017	0.352534	282.556	0.23838	348.3	0.179218	338.21
0.711222	265.158	0.354678	281.776	0.239819	347.645	0.180294	338.316

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
0.715475	264.313	0.356822	281.042	0.241257	346.937	0.18137	338.42
0.719728	263.482	0.358965	280.353	0.242695	346.179	0.182446	338.524
0.72398	262.66	0.361109	279.705	0.244134	345.371	0.183522	338.626
0.728233	261.839	0.363253	279.095	0.245572	344.514	0.184598	338.727
0.732486	261.005	0.365397	278.522	0.247011	343.615	0.185674	338.827
0.736739	260.128	0.36754	277.982	0.248449	342.679	0.18675	338.926
0.740992	259.161	0.369684	277.473	0.249888	341.706	0.187826	339.023
0.745244	258.108	0.371828	276.994	0.251326	340.692	0.188902	339.119
0.747874	257.447	0.373972	276.541	0.252765	339.638	0.189978	339.214
0.75	257.183	0.376115	276.113	0.254203	338.544	0.191054	339.306
		0.378259	275.707	0.255642	337.411	0.19213	339.398
		0.380403	275.32	0.25708	336.239	0.193206	339.487
		0.382547	274.951	0.258519	335.03	0.194282	339.575
		0.38469	274.595	0.259957	333.786	0.195358	339.661
		0.386834	274.25	0.261396	332.507	0.196434	339.745
		0.388978	273.916	0.262834	331.193	0.19751	339.826
		0.391122	273.591	0.264273	329.845	0.198586	339.906
		0.393265	273.277	0.265711	328.463	0.199662	339.983
		0.395409	272.976	0.267149	327.054	0.200738	340.058
		0.397553	272.687	0.268588	325.623	0.201814	340.13
		0.399697	272.409	0.270026	324.178	0.20289	340.199
		0.40184	272.139	0.271465	322.726	0.203966	340.266
		0.403984	271.875	0.272903	321.272	0.205042	340.329
		0.406128	271.617	0.274342	319.819	0.206118	340.39
		0.408272	271.365	0.27578	318.374	0.207194	340.448
		0.410415	271.12	0.277219	316.939	0.20827	340.502
		0.412559	270.882	0.278657	315.519	0.209346	340.554
		0.414703	270.65	0.280096	314.116	0.210422	340.601
		0.416847	270.423	0.281534	312.735	0.211498	340.639
		0.41899	270.2	0.282973	311.378	0.212574	340.652
		0.421134	269.981	0.284411	310.049	0.21365	340.634
		0.423278	269.767	0.28585	308.749	0.214726	340.591
		0.425422	269.558	0.287288	307.481	0.215802	340.534
		0.427565	269.352	0.288727	306.247	0.216878	340.468
		0.429709	269.15	0.290165	305.048	0.217954	340.393
		0.431853	268.949	0.291603	303.885	0.21903	340.309
		0.433997	268.751	0.293042	302.761	0.220106	340.215
		0.43614	268.554	0.29448	301.675	0.221182	340.112
		0.438284	268.36	0.295919	300.628	0.222258	340
		0.440428	268.167	0.297357	299.621	0.223334	339.876
		0.442572	267.977	0.298796	298.653	0.22441	339.742
		0.444715	267.79	0.300234	297.726	0.225485	339.594
		0.446859	267.605	0.301673	296.838	0.226561	339.432

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
		0.449003	267.425	0.303111	295.989	0.227637	339.255
		0.451147	267.249	0.30455	295.179	0.228713	339.058
		0.45329	267.076	0.305988	294.408	0.229789	338.837
		0.455434	266.905	0.307427	293.674	0.230865	338.583
		0.457578	266.738	0.308865	292.976	0.231941	338.294
		0.459722	266.573	0.310304	292.315	0.233017	337.974
		0.461865	266.411	0.311742	291.687	0.234093	337.627
		0.464009	266.25	0.313181	291.093	0.235169	337.258
		0.466153	266.09	0.314619	290.53	0.236245	336.866
		0.468297	265.932	0.316057	289.997	0.237321	336.452
		0.47044	265.775	0.317496	289.491	0.238397	336.017
		0.472584	265.62	0.318934	289.011	0.239473	335.56
		0.474728	265.467	0.320373	288.556	0.240549	335.082
		0.476872	265.315	0.321811	288.125	0.241625	334.583
		0.479015	265.164	0.32325	287.718	0.242701	334.062
		0.481159	265.014	0.324688	287.334	0.243777	333.519
		0.483303	264.865	0.326127	286.972	0.244853	332.953
		0.485447	264.716	0.327565	286.631	0.245929	332.364
		0.48759	264.568	0.329004	286.309	0.247005	331.75
		0.489734	264.421	0.330442	286.004	0.248081	331.11
		0.491878	264.274	0.331881	285.716	0.249157	330.443
		0.494022	264.129	0.333319	285.443	0.250233	329.751
		0.496165	263.983	0.334758	285.185	0.251309	329.039
		0.498309	263.838	0.336196	284.941	0.252385	328.301
		0.500453	263.694	0.337635	284.711	0.253461	327.537
		0.502597	263.549	0.339073	284.492	0.254537	326.751
		0.50474	263.404	0.340511	284.283	0.255613	325.946
		0.506884	263.259	0.34195	284.084	0.256689	325.123
		0.509028	263.113	0.343388	283.894	0.257765	324.285
		0.511172	262.968	0.344827	283.712	0.258841	323.435
		0.513315	262.822	0.346265	283.536	0.259917	322.573
		0.515459	262.677	0.347704	283.366	0.260993	321.702
		0.517603	262.531	0.349142	283.2	0.262069	320.823
		0.519747	262.386	0.350581	283.039	0.263145	319.938
		0.52189	262.241	0.352019	282.883	0.264221	319.049
		0.524034	262.095	0.353458	282.73	0.265297	318.156
		0.526178	261.95	0.354896	282.58	0.266373	317.262
		0.528322	261.804	0.356335	282.434	0.267449	316.367
		0.530465	261.658	0.357773	282.292	0.268525	315.474
		0.532609	261.512	0.359212	282.155	0.269601	314.583
		0.534753	261.365	0.36065	282.025	0.270677	313.695
		0.536897	261.218	0.362089	281.905	0.271753	312.812
		0.53904	261.071	0.363527	281.792	0.272829	311.935

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
		0.541184	260.924	0.364965	281.685	0.273905	311.066
		0.543328	260.777	0.366404	281.582	0.274981	310.204
		0.545472	260.629	0.367842	281.483	0.276057	309.352
		0.547615	260.482	0.369281	281.387	0.277133	308.51
		0.549759	260.334	0.370719	281.295	0.278209	307.679
		0.551903	260.186	0.372158	281.206	0.279285	306.861
		0.554047	260.038	0.373596	281.119	0.280361	306.056
		0.55619	259.888	0.375035	281.034	0.281436	305.265
		0.558334	259.738	0.376473	280.951	0.282512	304.492
		0.560478	259.587	0.377912	280.87	0.283588	303.736
		0.562622	259.435	0.37935	280.792	0.284664	302.999
		0.564765	259.281	0.380789	280.715	0.28574	302.283
		0.566909	259.127	0.382227	280.641	0.286816	301.588
		0.569053	258.971	0.383666	280.567	0.287892	300.914
		0.571197	258.813	0.385104	280.494	0.288968	300.261
		0.573341	258.655	0.386543	280.422	0.290044	299.629
		0.575484	258.495	0.387981	280.351	0.29112	299.019
		0.577628	258.335	0.389419	280.281	0.292196	298.43
		0.579772	258.173	0.390858	280.212	0.293272	297.861
		0.581915	258.01	0.392296	280.144	0.294348	297.313
		0.584059	257.847	0.393735	280.077	0.295424	296.784
		0.586203	257.683	0.395173	280.01	0.2965	296.274
		0.588347	257.518	0.396612	279.944	0.297576	295.783
		0.59049	257.354	0.39805	279.879	0.298652	295.31
		0.592634	257.189	0.399489	279.814	0.299728	294.856
		0.594778	257.023	0.400927	279.749	0.300804	294.419
		0.596922	256.858	0.402366	279.684	0.30188	294.001
		0.599066	256.693	0.403804	279.62	0.302956	293.6
		0.601209	256.528	0.405243	279.557	0.304032	293.216
		0.603353	256.363	0.406681	279.493	0.305108	292.849
		0.605497	256.197	0.40812	279.43	0.306184	292.498
		0.607641	256.032	0.409558	279.367	0.30726	292.163
		0.609784	255.867	0.410997	279.304	0.308336	291.842
		0.611928	255.701	0.412435	279.241	0.309412	291.535
		0.614072	255.535	0.413873	279.178	0.310488	291.242
		0.616216	255.368	0.415312	279.116	0.311564	290.963
		0.618359	255.2	0.41675	279.053	0.31264	290.696
		0.620503	255.032	0.418189	278.991	0.313716	290.443
		0.622647	254.863	0.419627	278.928	0.314792	290.2
		0.624791	254.693	0.421066	278.866	0.315868	289.97
		0.626934	254.523	0.422504	278.803	0.316944	289.75
		0.629078	254.353	0.423943	278.739	0.31802	289.541
		0.631222	254.182	0.425381	278.676	0.319096	289.341

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
		0.633366	254.01	0.42682	278.612	0.320172	289.15
		0.635509	253.838	0.428258	278.549	0.321248	288.968
		0.637653	253.665	0.429697	278.485	0.322324	288.794
		0.639797	253.492	0.431135	278.422	0.3234	288.627
		0.641941	253.317	0.432574	278.359	0.324476	288.467
		0.644084	253.141	0.434012	278.296	0.325552	288.312
		0.646228	252.965	0.435451	278.233	0.326628	288.162
		0.648372	252.788	0.436889	278.169	0.327704	288.018
		0.650516	252.611	0.438327	278.105	0.32878	287.878
		0.652659	252.433	0.439766	278.041	0.329856	287.743
		0.654803	252.254	0.441204	277.976	0.330932	287.614
		0.656947	252.075	0.442643	277.911	0.332008	287.489
		0.659091	251.895	0.444081	277.845	0.333084	287.368
		0.661234	251.714	0.44552	277.779	0.33416	287.25
		0.663378	251.534	0.446958	277.713	0.335236	287.135
		0.665522	251.352	0.448397	277.647	0.336312	287.022
		0.667666	251.17	0.449835	277.581	0.337388	286.912
		0.669809	250.988	0.451274	277.515	0.338463	286.803
		0.671953	250.805	0.452712	277.449	0.339539	286.697
		0.674097	250.621	0.454151	277.383	0.340615	286.594
		0.676241	250.437	0.455589	277.317	0.341691	286.494
		0.678384	250.252	0.457028	277.251	0.342767	286.396
		0.680528	250.067	0.458466	277.184	0.343843	286.301
		0.682672	249.881	0.459905	277.117	0.344919	286.212
		0.684816	249.694	0.461343	277.049	0.345995	286.129
		0.686959	249.507	0.462782	276.981	0.347071	286.051
		0.689103	249.318	0.46422	276.913	0.348147	285.978
		0.691247	249.129	0.465658	276.843	0.349223	285.907
		0.693391	248.939	0.467097	276.774	0.350299	285.838
		0.695534	248.748	0.468535	276.704	0.351375	285.772
		0.697678	248.557	0.469974	276.634	0.352451	285.707
		0.699822	248.363	0.471412	276.565	0.353527	285.645
		0.701966	248.169	0.472851	276.495	0.354603	285.584
		0.704109	247.974	0.474289	276.425	0.355679	285.525
		0.706253	247.777	0.475728	276.355	0.356755	285.467
		0.708397	247.578	0.477166	276.285	0.357831	285.411
		0.710541	247.378	0.478605	276.214	0.358907	285.355
		0.712684	247.176	0.480043	276.144	0.359983	285.301
		0.714828	246.972	0.481482	276.074	0.361059	285.248
		0.716972	246.765	0.48292	276.003	0.362135	285.196
		0.719116	246.555	0.484359	275.932	0.363211	285.145
		0.721259	246.342	0.485797	275.86	0.364287	285.096
		0.723403	246.125	0.487236	275.788	0.365363	285.046

Mesh 1		Mesh 2		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
		0.725547	245.902	0.488674	275.715	0.366439	284.998
		0.727691	245.672	0.490112	275.643	0.367515	284.949
		0.729834	245.432	0.491551	275.569	0.368591	284.901
		0.731978	245.182	0.492989	275.496	0.369667	284.854
		0.734122	244.918	0.494428	275.422	0.370743	284.808
		0.736266	244.64	0.495866	275.348	0.371819	284.763
		0.738409	244.349	0.497305	275.274	0.372895	284.718
		0.740553	244.044	0.498743	275.2	0.373971	284.673
		0.74263	243.742	0.500182	275.125	0.375047	284.628
		0.744472	243.474	0.50162	275.051	0.376123	284.583
		0.746004	243.254	0.503059	274.976	0.377199	284.539
		0.747227	243.081	0.504497	274.901	0.378275	284.494
		0.748198	242.943	0.505936	274.826	0.379351	284.451
		0.74896	242.832	0.507374	274.751	0.380427	284.408
		0.749551	242.746	0.508813	274.676	0.381503	284.365
		0.75	242.715	0.510251	274.601	0.382579	284.323
				0.51169	274.526	0.383655	284.28
				0.513128	274.451	0.384731	284.237
				0.514566	274.375	0.385807	284.195
				0.516005	274.299	0.386883	284.152
				0.517443	274.223	0.387959	284.11
				0.518882	274.146	0.389035	284.068
				0.52032	274.069	0.390111	284.026
				0.521759	273.992	0.391187	283.984
				0.523197	273.915	0.392262	283.943
				0.524636	273.837	0.393338	283.902
				0.526074	273.76	0.394414	283.86
				0.527513	273.681	0.39549	283.819
				0.528951	273.603	0.396566	283.777
				0.53039	273.525	0.397642	283.735
				0.531828	273.446	0.398718	283.694
				0.533267	273.368	0.399794	283.653
				0.534705	273.289	0.40087	283.611
				0.536144	273.21	0.401946	283.57
				0.537582	273.131	0.403022	283.529
				0.53902	273.051	0.404098	283.488
				0.540459	272.972	0.405174	283.447
				0.541897	272.893	0.40625	283.406
				0.543336	272.813	0.407326	283.365
				0.544774	272.733	0.408402	283.324
				0.546213	272.654	0.409478	283.283
				0.547651	272.574	0.410554	283.242
				0.54909	272.494	0.41163	283.2

Mesh 3		Mesh 4		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
0.550528	272.414	0.412706	283.159	0.612383	268.889	0.458973	281.348
0.551967	272.334	0.413782	283.118	0.613821	268.806	0.460049	281.305
0.553405	272.254	0.414858	283.077	0.615259	268.723	0.461125	281.261
0.554844	272.173	0.415934	283.036	0.616698	268.64	0.462201	281.218
0.556282	272.093	0.41701	282.995	0.618136	268.557	0.463277	281.175
0.557721	272.012	0.418086	282.953	0.619575	268.475	0.464353	281.131
0.559159	271.932	0.419162	282.912	0.621013	268.392	0.465429	281.087
0.560598	271.851	0.420238	282.871	0.622452	268.309	0.466505	281.043
0.562036	271.77	0.421314	282.829	0.62389	268.226	0.467581	281
0.563475	271.689	0.42239	282.788	0.625329	268.143	0.468657	280.956
0.564913	271.608	0.423466	282.746	0.626767	268.06	0.469733	280.912
0.566351	271.527	0.424542	282.705	0.628206	267.978	0.470809	280.868
0.56779	271.445	0.425618	282.663	0.629644	267.895	0.471885	280.824
0.569228	271.364	0.426694	282.622	0.631083	267.812	0.472961	280.78
0.570667	271.282	0.42777	282.58	0.632521	267.729	0.474037	280.736
0.572105	271.201	0.428846	282.539	0.63396	267.647	0.475113	280.692
0.573544	271.119	0.429922	282.497	0.635398	267.564	0.476189	280.648
0.574982	271.037	0.430998	282.455	0.636837	267.482	0.477265	280.604
0.576421	270.955	0.432074	282.413	0.638275	267.399	0.478341	280.56
0.577859	270.873	0.43315	282.371	0.639713	267.317	0.479417	280.516
0.579298	270.791	0.434226	282.329	0.641152	267.234	0.480493	280.472
0.580736	270.709	0.435302	282.287	0.64259	267.152	0.481569	280.428
0.582175	270.627	0.436378	282.244	0.644029	267.07	0.482645	280.383
0.583613	270.545	0.437454	282.202	0.645467	266.988	0.483721	280.339
0.585052	270.462	0.43853	282.16	0.646906	266.906	0.484797	280.295
0.58649	270.38	0.439606	282.118	0.648344	266.824	0.485873	280.25
0.587929	270.297	0.440682	282.076	0.649783	266.742	0.486949	280.206
0.589367	270.215	0.441758	282.034	0.651221	266.66	0.488025	280.161
0.590805	270.132	0.442834	281.992	0.65266	266.579	0.489101	280.116
0.592244	270.049	0.44391	281.949	0.654098	266.497	0.490177	280.071
0.593682	269.967	0.444986	281.907	0.655537	266.416	0.491253	280.027
0.595121	269.884	0.446062	281.864	0.656975	266.335	0.492329	279.982
0.596559	269.801	0.447138	281.821	0.658414	266.254	0.493405	279.937
0.597998	269.718	0.448214	281.778	0.659852	266.173	0.494481	279.892
0.599436	269.635	0.449289	281.735	0.661291	266.092	0.495557	279.847
0.600875	269.552	0.450365	281.692	0.662729	266.012	0.496633	279.802
0.602313	269.47	0.451441	281.649	0.664167	265.931	0.497709	279.757
0.603752	269.387	0.452517	281.606	0.665606	265.851	0.498785	279.712
0.60519	269.304	0.453593	281.563	0.667044	265.771	0.499861	279.667
0.606629	269.221	0.454669	281.52	0.668483	265.691	0.500937	279.622
0.608067	269.138	0.455745	281.477	0.669921	265.611	0.502013	279.577
0.609506	269.055	0.456821	281.434	0.67136	265.531	0.503089	279.532
0.610944	268.972	0.457897	281.391	0.672798	265.452	0.504165	279.487

Mesh 3		Mesh 4		Mesh 3		Mesh 4	
x	y	x	y	x	y	x	y
0.674237	265.372	0.50524	279.442	0.736091	261.862	0.551508	277.46
0.675675	265.293	0.506316	279.397	0.73753	261.768	0.552584	277.413
0.677114	265.214	0.507392	279.352	0.738968	261.676	0.55366	277.366
0.678552	265.135	0.508468	279.306	0.740406	261.587	0.554736	277.319
0.679991	265.056	0.509544	279.261	0.741845	261.504	0.555812	277.272
0.681429	264.978	0.51062	279.216	0.743283	261.427	0.556888	277.225
0.682868	264.899	0.511696	279.17	0.744713	261.357	0.557964	277.178
0.684306	264.821	0.512772	279.125	0.746063	261.297	0.55904	277.131
0.685745	264.743	0.513848	279.079	0.747234	261.248	0.560116	277.084
0.687183	264.665	0.514924	279.034	0.748194	261.208	0.561191	277.037
0.688621	264.587	0.516	278.988	0.748958	261.175	0.562267	276.99
0.69006	264.51	0.517076	278.943	0.749553	261.15	0.563343	276.943
0.691498	264.432	0.518152	278.897	0.75	261.141	0.564419	276.896
0.692937	264.355	0.519228	278.851			0.565495	276.849
0.694375	264.277	0.520304	278.806			0.566571	276.802
0.695814	264.2	0.52138	278.76			0.567647	276.754
0.697252	264.122	0.522456	278.714			0.568723	276.707
0.698691	264.045	0.523532	278.668			0.569799	276.66
0.700129	263.967	0.524608	278.622			0.570875	276.613
0.701568	263.889	0.525684	278.576			0.571951	276.566
0.703006	263.811	0.52676	278.53			0.573027	276.519
0.704445	263.733	0.527836	278.484			0.574103	276.471
0.705883	263.655	0.528912	278.438			0.575179	276.424
0.707322	263.577	0.529988	278.392			0.576255	276.377
0.70876	263.498	0.531064	278.346			0.577331	276.33
0.710199	263.419	0.53214	278.3			0.578407	276.283
0.711637	263.339	0.533216	278.254			0.579483	276.235
0.713075	263.259	0.534292	278.208			0.580559	276.188
0.714514	263.178	0.535368	278.161			0.581635	276.141
0.715952	263.097	0.536444	278.115			0.582711	276.094
0.717391	263.015	0.53752	278.068			0.583787	276.046
0.718829	262.933	0.538596	278.022			0.584863	275.999
0.720268	262.849	0.539672	277.975			0.585939	275.952
0.721706	262.765	0.540748	277.928			0.587015	275.905
0.723145	262.68	0.541824	277.882			0.588091	275.858
0.724583	262.594	0.5429	277.835			0.589167	275.811
0.726022	262.506	0.543976	277.788			0.590243	275.764
0.72746	262.418	0.545052	277.742			0.591319	275.717
0.728899	262.328	0.546128	277.695			0.592395	275.67
0.730337	262.237	0.547204	277.648			0.593471	275.623
0.731776	262.144	0.54828	277.601			0.594547	275.576
0.733214	262.051	0.549356	277.554			0.595623	275.529
0.734653	261.956	0.550432	277.507			0.596699	275.482

Mesh 4		Mesh 4		Mesh 4		Mesh 4	
x	y	x	y	x	y	x	y
0.597775	275.435	0.644042	273.513	0.690309	271.639	0.736576	269.54
0.598851	275.389	0.645118	273.471	0.691385	271.593	0.737652	269.492
0.599927	275.342	0.646194	273.428	0.692461	271.547	0.738728	269.445
0.601003	275.296	0.64727	273.385	0.693537	271.501	0.739804	269.399
0.602079	275.249	0.648346	273.342	0.694613	271.454	0.74088	269.354
0.603155	275.203	0.649422	273.3	0.695689	271.408	0.741956	269.31
0.604231	275.156	0.650498	273.257	0.696765	271.361	0.743032	269.268
0.605307	275.11	0.651574	273.215	0.697841	271.314	0.744108	269.227
0.606383	275.064	0.65265	273.172	0.698917	271.267	0.745184	269.187
0.607459	275.018	0.653726	273.129	0.699993	271.219	0.746258	269.147
0.608535	274.972	0.654802	273.087	0.701069	271.172	0.747305	269.107
0.609611	274.926	0.655878	273.044	0.702145	271.124	0.748236	269.069
0.610687	274.881	0.656954	273.001	0.703221	271.076	0.748987	269.034
0.611763	274.835	0.65803	272.958	0.704297	271.028	0.749573	269.005
0.612839	274.789	0.659106	272.916	0.705373	270.98	0.75	268.994
0.613915	274.744	0.660182	272.873	0.706449	270.932		
0.614991	274.699	0.661258	272.83	0.707525	270.884		
0.616067	274.654	0.662334	272.787	0.708601	270.835		
0.617143	274.608	0.66341	272.744	0.709677	270.787		
0.618218	274.563	0.664486	272.701	0.710753	270.738		
0.619294	274.518	0.665562	272.658	0.711829	270.689		
0.62037	274.474	0.666638	272.614	0.712905	270.64		
0.621446	274.429	0.667714	272.571	0.713981	270.591		
0.622522	274.384	0.66879	272.528	0.715057	270.542		
0.623598	274.34	0.669866	272.484	0.716133	270.492		
0.624674	274.296	0.670942	272.441	0.717209	270.443		
0.62575	274.251	0.672018	272.397	0.718285	270.393		
0.626826	274.207	0.673094	272.354	0.719361	270.343		
0.627902	274.163	0.67417	272.31	0.720437	270.293		
0.628978	274.119	0.675245	272.266	0.721513	270.243		
0.630054	274.075	0.676321	272.222	0.722589	270.193		
0.63113	274.032	0.677397	272.178	0.723665	270.143		
0.632206	273.988	0.678473	272.134	0.724741	270.092		
0.633282	273.944	0.679549	272.09	0.725817	270.042		
0.634358	273.901	0.680625	272.046	0.726893	269.991		
0.635434	273.858	0.681701	272.001	0.727969	269.941		
0.63651	273.814	0.682777	271.956	0.729045	269.89		
0.637586	273.771	0.683853	271.911	0.730121	269.839		
0.638662	273.728	0.684929	271.866	0.731196	269.789		
0.639738	273.685	0.686005	271.821	0.732272	269.738		
0.640814	273.642	0.687081	271.776	0.733348	269.688		
0.64189	273.599	0.688157	271.731	0.734424	269.638		
0.642966	273.556	0.689233	271.685	0.7355	269.589		

APPENDIX IV: GRID SIZE OPTIMIZATION DATA (MESH 5 - 8)

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.000429	349.466	0.000376	342.168	0.000327	320.322	0.000323	316.835
0.000963	349.26	0.000789	341.978	0.000654	320.137	0.000646	316.615
0.001637	348.904	0.001311	341.639	0.000999	319.854	0.000974	316.285
0.002443	348.4	0.001945	341.141	0.001396	319.445	0.00134	315.823
0.003357	347.769	0.002698	340.476	0.001865	318.879	0.001768	315.193
0.004293	347.083	0.003532	339.686	0.002414	318.139	0.002273	314.376
0.005229	346.365	0.004365	338.858	0.003039	317.227	0.002867	313.359
0.006165	345.62	0.005199	337.997	0.003692	316.22	0.003511	312.233
0.007102	344.851	0.006033	337.109	0.004345	315.176	0.004155	311.11
0.008038	344.061	0.006867	336.198	0.004998	314.106	0.0048	310.013
0.008974	343.251	0.0077	335.267	0.005651	313.026	0.005444	308.964
0.00991	342.424	0.008534	334.318	0.006303	311.954	0.006089	307.98
0.010847	341.581	0.009368	333.352	0.006956	310.906	0.006734	307.077
0.011783	340.722	0.010201	332.372	0.007609	309.9	0.007378	306.265
0.012719	339.851	0.011035	331.377	0.008262	308.951	0.008023	305.548
0.013655	338.966	0.011869	330.368	0.008915	308.069	0.008668	304.926
0.014592	338.07	0.012702	329.345	0.009568	307.265	0.009312	304.395
0.015528	337.162	0.013536	328.307	0.010221	306.542	0.009957	303.949
0.016464	336.243	0.01437	327.256	0.010874	305.902	0.010602	303.579
0.0174	335.313	0.015204	326.191	0.011527	305.345	0.011246	303.275
0.018337	334.373	0.016037	325.116	0.012179	304.865	0.011891	303.027
0.019273	333.423	0.016871	324.031	0.012832	304.458	0.012536	302.826
0.020209	332.462	0.017705	322.942	0.013485	304.116	0.01318	302.664
0.021145	331.492	0.018538	321.851	0.014138	303.831	0.013825	302.533
0.022082	330.512	0.019372	320.765	0.014791	303.596	0.01447	302.427
0.023018	329.525	0.020206	319.69	0.015444	303.404	0.015114	302.342
0.023954	328.53	0.021039	318.633	0.016097	303.247	0.015759	302.274
0.02489	327.532	0.021873	317.601	0.01675	303.12	0.016404	302.22
0.025827	326.532	0.022707	316.602	0.017403	303.018	0.017048	302.178
0.026763	325.536	0.023541	315.643	0.018056	302.937	0.017693	302.146
0.027699	324.548	0.024374	314.732	0.018708	302.874	0.018338	302.122
0.028635	323.573	0.025208	313.874	0.019361	302.826	0.018982	302.107
0.029572	322.617	0.026042	313.076	0.020014	302.791	0.019627	302.099
0.030508	321.684	0.026875	312.34	0.020667	302.767	0.020272	302.095
0.031444	320.779	0.027709	311.671	0.02132	302.753	0.020916	302.094
0.03238	319.907	0.028543	311.069	0.021973	302.745	0.021561	302.094
0.033317	319.077	0.029376	310.535	0.022626	302.742	0.022206	302.094
0.034253	318.295	0.03021	310.07	0.023279	302.741	0.022851	302.094
0.035189	317.567	0.031044	309.672	0.023932	302.741	0.023495	302.094
0.036125	316.897	0.031878	309.336	0.024584	302.74	0.02414	302.094
0.037062	316.283	0.032711	309.059	0.025237	302.74	0.024785	302.095

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.037998	315.724	0.033545	308.837	0.02589	302.741	0.025429	302.098
0.038934	315.22	0.034379	308.669	0.026543	302.741	0.026074	302.103
0.03987	314.778	0.035212	308.549	0.027196	302.742	0.026719	302.111
0.040807	314.402	0.036046	308.464	0.027849	302.744	0.027363	302.121
0.041743	314.094	0.03688	308.408	0.028502	302.748	0.028008	302.133
0.042679	313.849	0.037713	308.375	0.029155	302.755	0.028653	302.148
0.043616	313.652	0.038547	308.361	0.029808	302.765	0.029297	302.163
0.044552	313.493	0.039381	308.355	0.030461	302.777	0.029942	302.18
0.045488	313.369	0.040215	308.353	0.031113	302.792	0.030587	302.198
0.046424	313.284	0.041048	308.351	0.031766	302.809	0.031231	302.217
0.047361	313.236	0.041882	308.351	0.032419	302.829	0.031876	302.237
0.048297	313.212	0.042716	308.351	0.033072	302.851	0.032521	302.258
0.049233	313.199	0.043549	308.351	0.033725	302.875	0.033165	302.28
0.050169	313.192	0.044383	308.354	0.034378	302.9	0.03381	302.303
0.051106	313.187	0.045217	308.365	0.035031	302.925	0.034455	302.326
0.052042	313.185	0.04605	308.393	0.035684	302.952	0.035099	302.35
0.052978	313.184	0.046884	308.445	0.036337	302.979	0.035744	302.374
0.053914	313.184	0.047718	308.52	0.036989	303.008	0.036389	302.399
0.054851	313.185	0.048552	308.611	0.037642	303.037	0.037033	302.425
0.055787	313.186	0.049385	308.715	0.038295	303.067	0.037678	302.451
0.056723	313.19	0.050219	308.826	0.038948	303.098	0.038323	302.478
0.057659	313.203	0.051053	308.945	0.039601	303.13	0.038967	302.506
0.058596	313.242	0.051886	309.069	0.040254	303.162	0.039612	302.534
0.059532	313.316	0.05272	309.198	0.040907	303.196	0.040257	302.562
0.060468	313.426	0.053554	309.329	0.04156	303.23	0.040901	302.591
0.061404	313.566	0.054387	309.463	0.042213	303.265	0.041546	302.62
0.062341	313.731	0.055221	309.598	0.042865	303.301	0.042191	302.65
0.063277	313.912	0.056055	309.735	0.043518	303.337	0.042835	302.68
0.064213	314.101	0.056889	309.873	0.044171	303.375	0.04348	302.71
0.065149	314.296	0.057722	310.013	0.044824	303.413	0.044125	302.741
0.066086	314.495	0.058556	310.153	0.045477	303.451	0.044769	302.772
0.067022	314.7	0.05939	310.295	0.04613	303.49	0.045414	302.804
0.067958	314.911	0.060223	310.437	0.046783	303.529	0.046059	302.836
0.068894	315.126	0.061057	310.58	0.047436	303.569	0.046703	302.868
0.069831	315.345	0.061891	310.724	0.048089	303.61	0.047348	302.9
0.070767	315.566	0.062724	310.868	0.048742	303.65	0.047993	302.932
0.071703	315.79	0.063558	311.013	0.049394	303.691	0.048637	302.965
0.072639	316.014	0.064392	311.158	0.050047	303.733	0.049282	302.998
0.073576	316.239	0.065226	311.303	0.0507	303.775	0.049927	303.031
0.074512	316.464	0.066059	311.448	0.051353	303.817	0.050571	303.064
0.075448	316.69	0.066893	311.594	0.052006	303.859	0.051216	303.096
0.076384	316.915	0.067727	311.739	0.052659	303.902	0.051861	303.129
0.077321	317.139	0.06856	311.885	0.053312	303.945	0.052505	303.163

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.078257	317.364	0.069394	312.031	0.053965	303.988	0.05315	303.196
0.079193	317.587	0.070228	312.176	0.054618	304.032	0.053795	303.229
0.080129	317.81	0.071061	312.322	0.05527	304.076	0.054439	303.262
0.081066	318.031	0.071895	312.467	0.055923	304.12	0.055084	303.296
0.082002	318.251	0.072729	312.612	0.056576	304.164	0.055729	303.329
0.082938	318.47	0.073563	312.756	0.057229	304.208	0.056373	303.363
0.083874	318.687	0.074396	312.9	0.057882	304.253	0.057018	303.397
0.084811	318.902	0.07523	313.043	0.058535	304.297	0.057663	303.431
0.085747	319.113	0.076064	313.186	0.059188	304.342	0.058307	303.465
0.086683	319.322	0.076897	313.327	0.059841	304.387	0.058952	303.499
0.087619	319.526	0.077731	313.466	0.060494	304.432	0.059597	303.533
0.088556	319.726	0.078565	313.603	0.061147	304.477	0.060241	303.567
0.089492	319.922	0.079398	313.738	0.061799	304.522	0.060886	303.602
0.090428	320.115	0.080232	313.871	0.062452	304.567	0.061531	303.636
0.091364	320.306	0.081066	314.002	0.063105	304.612	0.062175	303.671
0.092301	320.493	0.0819	314.131	0.063758	304.657	0.06282	303.706
0.093237	320.679	0.082733	314.259	0.064411	304.702	0.063465	303.74
0.094173	320.862	0.083567	314.386	0.065064	304.747	0.064109	303.775
0.095109	321.043	0.084401	314.511	0.065717	304.791	0.064754	303.81
0.096046	321.221	0.085234	314.635	0.06637	304.835	0.065399	303.845
0.096982	321.398	0.086068	314.758	0.067023	304.878	0.066043	303.879
0.097918	321.573	0.086902	314.879	0.067675	304.922	0.066688	303.914
0.098854	321.746	0.087735	314.999	0.068328	304.965	0.067333	303.949
0.099791	321.917	0.088569	315.118	0.068981	305.008	0.067977	303.983
0.100727	322.086	0.089403	315.236	0.069634	305.051	0.068622	304.018
0.101663	322.253	0.090237	315.352	0.070287	305.093	0.069267	304.052
0.1026	322.418	0.09107	315.467	0.07094	305.136	0.069911	304.085
0.103536	322.58	0.091904	315.581	0.071593	305.178	0.070556	304.119
0.104472	322.741	0.092738	315.694	0.072246	305.219	0.071201	304.153
0.105408	322.9	0.093571	315.806	0.072899	305.261	0.071845	304.186
0.106345	323.057	0.094405	315.916	0.073552	305.302	0.07249	304.219
0.107281	323.212	0.095239	316.026	0.074204	305.343	0.073135	304.252
0.108217	323.364	0.096072	316.134	0.074857	305.384	0.073779	304.285
0.109153	323.515	0.096906	316.241	0.07551	305.424	0.074424	304.318
0.11009	323.663	0.09774	316.346	0.076163	305.464	0.075069	304.35
0.111026	323.81	0.098574	316.45	0.076816	305.504	0.075714	304.383
0.111962	323.954	0.099407	316.553	0.077469	305.543	0.076358	304.415
0.112898	324.097	0.100241	316.655	0.078122	305.582	0.077003	304.447
0.113835	324.237	0.101075	316.755	0.078775	305.621	0.077648	304.478
0.114771	324.376	0.101908	316.854	0.079428	305.66	0.078292	304.51
0.115707	324.512	0.102742	316.952	0.08008	305.698	0.078937	304.541
0.116643	324.646	0.103576	317.048	0.080733	305.736	0.079582	304.572
0.11758	324.779	0.104409	317.143	0.081386	305.774	0.080226	304.603

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.118516	324.909	0.105243	317.237	0.082039	305.812	0.080871	304.634
0.119452	325.036	0.106077	317.33	0.082692	305.849	0.081516	304.664
0.120388	325.161	0.106911	317.421	0.083345	305.885	0.08216	304.694
0.121325	325.283	0.107744	317.512	0.083998	305.922	0.082805	304.724
0.122261	325.399	0.108578	317.601	0.084651	305.958	0.08345	304.754
0.123197	325.511	0.109412	317.689	0.085304	305.994	0.084094	304.784
0.124133	325.62	0.110245	317.775	0.085957	306.03	0.084739	304.813
0.12507	325.727	0.111079	317.861	0.086609	306.065	0.085384	304.842
0.126006	325.833	0.111913	317.945	0.087262	306.1	0.086028	304.871
0.126942	325.937	0.112746	318.029	0.087915	306.135	0.086673	304.9
0.127878	326.039	0.11358	318.111	0.088568	306.169	0.087318	304.929
0.128815	326.141	0.114414	318.192	0.089221	306.203	0.087962	304.957
0.129751	326.241	0.115248	318.272	0.089874	306.237	0.088607	304.986
0.130687	326.341	0.116081	318.35	0.090527	306.27	0.089252	305.014
0.131623	326.439	0.116915	318.426	0.09118	306.304	0.089896	305.042
0.13256	326.536	0.117749	318.5	0.091833	306.337	0.090541	305.069
0.133496	326.632	0.118582	318.572	0.092485	306.369	0.091186	305.097
0.134432	326.727	0.119416	318.641	0.093138	306.402	0.09183	305.124
0.135368	326.822	0.12025	318.709	0.093791	306.434	0.092475	305.151
0.136305	326.915	0.121083	318.777	0.094444	306.466	0.09312	305.178
0.137241	327.007	0.121917	318.844	0.095097	306.497	0.093764	305.205
0.138177	327.099	0.122751	318.91	0.09575	306.529	0.094409	305.232
0.139113	327.19	0.123584	318.975	0.096403	306.56	0.095054	305.258
0.14005	327.28	0.124418	319.04	0.097056	306.591	0.095698	305.284
0.140986	327.369	0.125252	319.104	0.097709	306.621	0.096343	305.31
0.141922	327.458	0.126086	319.167	0.098362	306.651	0.096988	305.336
0.142858	327.546	0.126919	319.23	0.099014	306.682	0.097632	305.362
0.143795	327.633	0.127753	319.292	0.099667	306.712	0.098277	305.388
0.144731	327.72	0.128587	319.354	0.10032	306.741	0.098922	305.413
0.145667	327.806	0.12942	319.415	0.100973	306.771	0.099566	305.438
0.146603	327.892	0.130254	319.476	0.101626	306.8	0.100211	305.464
0.14754	327.977	0.131088	319.536	0.102279	306.829	0.100856	305.489
0.148476	328.061	0.131921	319.596	0.102932	306.857	0.1015	305.514
0.149412	328.145	0.132755	319.655	0.103585	306.886	0.102145	305.538
0.150349	328.229	0.133589	319.714	0.104238	306.914	0.10279	305.563
0.151285	328.312	0.134423	319.773	0.10489	306.943	0.103434	305.587
0.152221	328.395	0.135256	319.831	0.105543	306.97	0.104079	305.612
0.153157	328.477	0.13609	319.888	0.106196	306.998	0.104724	305.636
0.154094	328.558	0.136924	319.946	0.106849	307.026	0.105368	305.66
0.15503	328.639	0.137757	320.003	0.107502	307.053	0.106013	305.684
0.155966	328.72	0.138591	320.06	0.108155	307.081	0.106658	305.708
0.156902	328.801	0.139425	320.116	0.108808	307.108	0.107302	305.732
0.157839	328.88	0.140258	320.172	0.109461	307.134	0.107947	305.755

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.158775	328.96	0.141092	320.228	0.110114	307.161	0.108592	305.779
0.159711	329.039	0.141926	320.283	0.110767	307.188	0.109236	305.802
0.160647	329.118	0.14276	320.339	0.111419	307.214	0.109881	305.825
0.161584	329.196	0.143593	320.393	0.112072	307.241	0.110526	305.849
0.16252	329.274	0.144427	320.448	0.112725	307.267	0.11117	305.872
0.163456	329.351	0.145261	320.503	0.113378	307.293	0.111815	305.895
0.164392	329.428	0.146094	320.557	0.114031	307.318	0.11246	305.918
0.165329	329.505	0.146928	320.611	0.114684	307.343	0.113104	305.941
0.166265	329.581	0.147762	320.665	0.115337	307.368	0.113749	305.964
0.167201	329.657	0.148595	320.718	0.11599	307.393	0.114394	305.987
0.168137	329.732	0.149429	320.772	0.116643	307.418	0.115038	306.009
0.169074	329.807	0.150263	320.825	0.117295	307.442	0.115683	306.032
0.17001	329.881	0.151097	320.878	0.117948	307.467	0.116328	306.055
0.170946	329.955	0.15193	320.931	0.118601	307.491	0.116972	306.077
0.171882	330.028	0.152764	320.984	0.119254	307.515	0.117617	306.1
0.172819	330.101	0.153598	321.036	0.119907	307.539	0.118262	306.122
0.173755	330.173	0.154431	321.088	0.12056	307.563	0.118906	306.144
0.174691	330.245	0.155265	321.141	0.121213	307.587	0.119551	306.166
0.175627	330.316	0.156099	321.192	0.121866	307.611	0.120196	306.189
0.176564	330.387	0.156933	321.244	0.122519	307.635	0.12084	306.211
0.1775	330.457	0.157766	321.296	0.123172	307.659	0.121485	306.233
0.178436	330.527	0.1586	321.347	0.123824	307.683	0.12213	306.255
0.179372	330.595	0.159434	321.398	0.124477	307.706	0.122774	306.277
0.180309	330.664	0.160267	321.45	0.12513	307.73	0.123419	306.299
0.181245	330.731	0.161101	321.5	0.125783	307.753	0.124064	306.321
0.182181	330.798	0.161935	321.551	0.126436	307.777	0.124708	306.342
0.183117	330.864	0.162768	321.602	0.127089	307.8	0.125353	306.364
0.184054	330.93	0.163602	321.652	0.127742	307.824	0.125998	306.386
0.18499	330.994	0.164436	321.702	0.128395	307.847	0.126642	306.408
0.185926	331.058	0.16527	321.752	0.129048	307.87	0.127287	306.43
0.186862	331.121	0.166103	321.802	0.1297	307.894	0.127932	306.451
0.187799	331.183	0.166937	321.851	0.130353	307.917	0.128577	306.473
0.188735	331.244	0.167771	321.9	0.131006	307.94	0.129221	306.495
0.189671	331.304	0.168604	321.949	0.131659	307.963	0.129866	306.516
0.190607	331.363	0.169438	321.998	0.132312	307.986	0.130511	306.538
0.191544	331.421	0.170272	322.047	0.132965	308.009	0.131155	306.56
0.19248	331.478	0.171105	322.095	0.133618	308.032	0.1318	306.581
0.193416	331.533	0.171939	322.143	0.134271	308.056	0.132445	306.603
0.194352	331.588	0.172773	322.191	0.134924	308.078	0.133089	306.624
0.195289	331.641	0.173607	322.239	0.135576	308.101	0.133734	306.646
0.196225	331.693	0.17444	322.286	0.136229	308.124	0.134379	306.667
0.197161	331.743	0.175274	322.333	0.136882	308.147	0.135023	306.688
0.198097	331.792	0.176108	322.379	0.137535	308.17	0.135668	306.71

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.199034	331.839	0.176941	322.425	0.138188	308.193	0.136313	306.731
0.19997	331.884	0.177775	322.471	0.138841	308.216	0.136957	306.752
0.200906	331.928	0.178609	322.517	0.139494	308.239	0.137602	306.773
0.201843	331.971	0.179442	322.562	0.140147	308.262	0.138247	306.794
0.202779	332.011	0.180276	322.606	0.1408	308.284	0.138891	306.815
0.203715	332.05	0.18111	322.651	0.141453	308.307	0.139536	306.836
0.204651	332.086	0.181944	322.695	0.142105	308.33	0.140181	306.857
0.205588	332.121	0.182777	322.738	0.142758	308.353	0.140825	306.878
0.206524	332.154	0.183611	322.781	0.143411	308.376	0.14147	306.899
0.20746	332.185	0.184445	322.823	0.144064	308.399	0.142115	306.92
0.208396	332.212	0.185278	322.865	0.144717	308.421	0.142759	306.941
0.209333	332.23	0.186112	322.906	0.14537	308.444	0.143404	306.961
0.210269	332.228	0.186946	322.947	0.146023	308.467	0.144049	306.982
0.211205	332.207	0.187779	322.987	0.146676	308.49	0.144693	307.003
0.212141	332.174	0.188613	323.027	0.147329	308.512	0.145338	307.024
0.213078	332.136	0.189447	323.066	0.147981	308.535	0.145983	307.045
0.214014	332.093	0.19028	323.104	0.148634	308.557	0.146627	307.065
0.21495	332.044	0.191114	323.141	0.149287	308.58	0.147272	307.086
0.215886	331.991	0.191948	323.178	0.14994	308.603	0.147917	307.107
0.216823	331.932	0.192782	323.214	0.150593	308.625	0.148561	307.128
0.217759	331.867	0.193615	323.249	0.151246	308.648	0.149206	307.148
0.218695	331.797	0.194449	323.283	0.151899	308.671	0.149851	307.169
0.219631	331.721	0.195283	323.317	0.152552	308.693	0.150495	307.19
0.220568	331.638	0.196116	323.349	0.153205	308.716	0.15114	307.21
0.221504	331.548	0.19695	323.381	0.153858	308.738	0.151785	307.231
0.22244	331.449	0.197784	323.411	0.15451	308.761	0.152429	307.252
0.223376	331.342	0.198617	323.441	0.155163	308.783	0.153074	307.272
0.224313	331.223	0.199451	323.469	0.155816	308.805	0.153719	307.293
0.225249	331.09	0.200285	323.497	0.156469	308.828	0.154363	307.313
0.226185	330.938	0.201119	323.523	0.157122	308.85	0.155008	307.334
0.227121	330.765	0.201952	323.548	0.157775	308.873	0.155653	307.355
0.228058	330.573	0.202786	323.572	0.158428	308.895	0.156297	307.375
0.228994	330.366	0.20362	323.595	0.159081	308.917	0.156942	307.396
0.22993	330.145	0.204453	323.617	0.159734	308.94	0.157587	307.416
0.230866	329.911	0.205287	323.637	0.160387	308.962	0.158231	307.437
0.231803	329.665	0.206121	323.656	0.161039	308.984	0.158876	307.457
0.232739	329.406	0.206954	323.674	0.161692	309.006	0.159521	307.478
0.233675	329.134	0.207788	323.686	0.162345	309.029	0.160165	307.498
0.234611	328.85	0.208622	323.688	0.162998	309.051	0.16081	307.519
0.235548	328.553	0.209456	323.676	0.163651	309.073	0.161455	307.539
0.236484	328.243	0.210289	323.657	0.164304	309.095	0.162099	307.56
0.23742	327.921	0.211123	323.635	0.164957	309.118	0.162744	307.58
0.238356	327.586	0.211957	323.609	0.16561	309.14	0.163389	307.601

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.239293	327.238	0.21279	323.58	0.166263	309.162	0.164033	307.621
0.240229	326.876	0.213624	323.547	0.166915	309.184	0.164678	307.641
0.241165	326.498	0.214458	323.512	0.167568	309.206	0.165323	307.662
0.242101	326.103	0.215291	323.474	0.168221	309.228	0.165967	307.682
0.243038	325.687	0.216125	323.432	0.168874	309.25	0.166612	307.702
0.243974	325.249	0.216959	323.386	0.169527	309.272	0.167257	307.722
0.24491	324.788	0.217793	323.337	0.17018	309.294	0.167901	307.743
0.245846	324.305	0.218626	323.284	0.170833	309.316	0.168546	307.763
0.246783	323.804	0.21946	323.226	0.171486	309.337	0.169191	307.783
0.247719	323.285	0.220294	323.163	0.172139	309.359	0.169835	307.803
0.248655	322.755	0.221127	323.095	0.172792	309.381	0.17048	307.823
0.249591	322.217	0.221961	323.019	0.173444	309.402	0.171125	307.843
0.250528	321.67	0.222795	322.934	0.174097	309.424	0.171769	307.863
0.251464	321.113	0.223628	322.836	0.17475	309.445	0.172414	307.884
0.2524	320.548	0.224462	322.726	0.175403	309.466	0.173059	307.903
0.253336	319.974	0.225296	322.606	0.176056	309.488	0.173704	307.923
0.254273	319.391	0.22613	322.477	0.176709	309.509	0.174348	307.943
0.255209	318.8	0.226963	322.341	0.177362	309.53	0.174993	307.963
0.256145	318.2	0.227797	322.198	0.178015	309.551	0.175638	307.982
0.257081	317.591	0.228631	322.047	0.178668	309.572	0.176282	308.002
0.258018	316.974	0.229464	321.888	0.17932	309.592	0.176927	308.021
0.258954	316.348	0.230298	321.723	0.179973	309.613	0.177572	308.041
0.25989	315.713	0.231132	321.55	0.180626	309.633	0.178216	308.06
0.260827	315.072	0.231965	321.37	0.181279	309.654	0.178861	308.079
0.261763	314.426	0.232799	321.182	0.181932	309.674	0.179506	308.098
0.262699	313.777	0.233633	320.988	0.182585	309.694	0.18015	308.117
0.263635	313.127	0.234467	320.785	0.183238	309.715	0.180795	308.136
0.264572	312.477	0.2353	320.575	0.183891	309.735	0.18144	308.155
0.265508	311.83	0.236134	320.356	0.184544	309.754	0.182084	308.174
0.266444	311.184	0.236968	320.128	0.185197	309.774	0.182729	308.193
0.26738	310.543	0.237801	319.89	0.185849	309.794	0.183374	308.211
0.268317	309.906	0.238635	319.64	0.186502	309.813	0.184018	308.23
0.269253	309.274	0.239469	319.377	0.187155	309.832	0.184663	308.248
0.270189	308.647	0.240302	319.1	0.187808	309.851	0.185308	308.266
0.271125	308.026	0.241136	318.812	0.188461	309.87	0.185952	308.284
0.272062	307.411	0.24197	318.513	0.189114	309.889	0.186597	308.302
0.272998	306.802	0.242804	318.204	0.189767	309.907	0.187242	308.319
0.273934	306.201	0.243637	317.887	0.19042	309.925	0.187886	308.337
0.27487	305.607	0.244471	317.561	0.191073	309.943	0.188531	308.354
0.275807	305.023	0.245305	317.227	0.191725	309.961	0.189176	308.372
0.276743	304.449	0.246138	316.884	0.192378	309.979	0.18982	308.389
0.277679	303.886	0.246972	316.533	0.193031	309.996	0.190465	308.406
0.278615	303.335	0.247806	316.172	0.193684	310.013	0.19111	308.422

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.279552	302.796	0.248639	315.801	0.194337	310.029	0.191754	308.439
0.280488	302.27	0.249473	315.421	0.19499	310.046	0.192399	308.455
0.281424	301.756	0.250307	315.036	0.195643	310.062	0.193044	308.471
0.28236	301.255	0.251141	314.645	0.196296	310.078	0.193688	308.486
0.283297	300.766	0.251974	314.247	0.196949	310.093	0.194333	308.502
0.284233	300.289	0.252808	313.844	0.197602	310.108	0.194978	308.517
0.285169	299.826	0.253642	313.437	0.198254	310.123	0.195622	308.532
0.286105	299.375	0.254475	313.025	0.198907	310.137	0.196267	308.547
0.287042	298.938	0.255309	312.611	0.19956	310.151	0.196912	308.561
0.287978	298.513	0.256143	312.194	0.200213	310.165	0.197556	308.575
0.288914	298.102	0.256976	311.774	0.200866	310.178	0.198201	308.589
0.28985	297.704	0.25781	311.351	0.201519	310.191	0.198846	308.602
0.290787	297.319	0.258644	310.927	0.202172	310.204	0.19949	308.615
0.291723	296.947	0.259478	310.5	0.202825	310.216	0.200135	308.628
0.292659	296.587	0.260311	310.071	0.203478	310.228	0.20078	308.641
0.293595	296.24	0.261145	309.642	0.20413	310.239	0.201424	308.653
0.294532	295.905	0.261979	309.212	0.204783	310.25	0.202069	308.664
0.295468	295.583	0.262812	308.783	0.205436	310.261	0.202714	308.676
0.296404	295.272	0.263646	308.355	0.206089	310.271	0.203358	308.687
0.29734	294.973	0.26448	307.929	0.206742	310.28	0.204003	308.698
0.298277	294.685	0.265313	307.505	0.207395	310.289	0.204648	308.708
0.299213	294.408	0.266147	307.085	0.208048	310.298	0.205292	308.718
0.300149	294.142	0.266981	306.668	0.208701	310.306	0.205937	308.727
0.301085	293.887	0.267815	306.254	0.209354	310.314	0.206582	308.736
0.302022	293.642	0.268648	305.844	0.210006	310.321	0.207226	308.745
0.302958	293.407	0.269482	305.439	0.210659	310.328	0.207871	308.753
0.303894	293.181	0.270316	305.039	0.211312	310.334	0.208516	308.761
0.30483	292.965	0.271149	304.644	0.211965	310.339	0.20916	308.769
0.305767	292.758	0.271983	304.254	0.212618	310.343	0.209805	308.776
0.306703	292.559	0.272817	303.871	0.213271	310.342	0.21045	308.782
0.307639	292.369	0.27365	303.494	0.213924	310.337	0.211094	308.788
0.308575	292.187	0.274484	303.124	0.214577	310.33	0.211739	308.794
0.309512	292.012	0.275318	302.76	0.21523	310.322	0.212384	308.799
0.310448	291.845	0.276152	302.403	0.215883	310.313	0.213028	308.804
0.311384	291.684	0.276985	302.053	0.216535	310.302	0.213673	308.807
0.31232	291.53	0.277819	301.711	0.217188	310.291	0.214318	308.806
0.313257	291.382	0.278653	301.376	0.217841	310.278	0.214962	308.802
0.314193	291.239	0.279486	301.048	0.218494	310.265	0.215607	308.796
0.315129	291.101	0.28032	300.729	0.219147	310.25	0.216252	308.789
0.316066	290.968	0.281154	300.417	0.2198	310.235	0.216896	308.782
0.317002	290.838	0.281987	300.112	0.220453	310.218	0.217541	308.773
0.317938	290.712	0.282821	299.816	0.221106	310.2	0.218186	308.763
0.318874	290.59	0.283655	299.528	0.221759	310.181	0.21883	308.753

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.319811	290.472	0.284489	299.247	0.222411	310.16	0.219475	308.741
0.320747	290.358	0.285322	298.974	0.223064	310.138	0.22012	308.729
0.321683	290.249	0.286156	298.709	0.223717	310.114	0.220764	308.715
0.322619	290.145	0.28699	298.452	0.22437	310.089	0.221409	308.701
0.323556	290.046	0.287823	298.202	0.225023	310.062	0.222054	308.685
0.324492	289.95	0.288657	297.96	0.225676	310.033	0.222698	308.668
0.325428	289.858	0.289491	297.726	0.226329	310.002	0.223343	308.65
0.326364	289.767	0.290324	297.499	0.226982	309.967	0.223988	308.631
0.327301	289.68	0.291158	297.279	0.227635	309.93	0.224632	308.61
0.328237	289.594	0.291992	297.066	0.228288	309.89	0.225277	308.587
0.329173	289.51	0.292826	296.86	0.22894	309.85	0.225922	308.562
0.330109	289.428	0.293659	296.661	0.229593	309.809	0.226566	308.533
0.331046	289.348	0.294493	296.469	0.230246	309.768	0.227211	308.502
0.331982	289.27	0.295327	296.284	0.230899	309.726	0.227856	308.47
0.332918	289.193	0.29616	296.104	0.231552	309.683	0.228501	308.435
0.333854	289.119	0.296994	295.931	0.232205	309.64	0.229145	308.398
0.334791	289.046	0.297828	295.765	0.232858	309.595	0.22979	308.36
0.335727	288.975	0.298661	295.603	0.233511	309.55	0.230435	308.32
0.336663	288.906	0.299495	295.448	0.234164	309.503	0.231079	308.279
0.337599	288.838	0.300329	295.298	0.234816	309.454	0.231724	308.236
0.338536	288.772	0.301163	295.154	0.235469	309.405	0.232369	308.191
0.339472	288.708	0.301996	295.014	0.236122	309.353	0.233013	308.145
0.340408	288.646	0.30283	294.88	0.236775	309.3	0.233658	308.097
0.341344	288.587	0.303664	294.75	0.237428	309.245	0.234303	308.047
0.342281	288.531	0.304497	294.625	0.238081	309.189	0.234947	307.996
0.343217	288.478	0.305331	294.505	0.238734	309.13	0.235592	307.943
0.344153	288.426	0.306165	294.388	0.239387	309.069	0.236237	307.888
0.345089	288.376	0.306998	294.276	0.24004	309.006	0.236881	307.832
0.346026	288.327	0.307832	294.167	0.240692	308.941	0.237526	307.774
0.346962	288.28	0.308666	294.061	0.241345	308.873	0.238171	307.714
0.347898	288.234	0.3095	293.958	0.241998	308.803	0.238815	307.652
0.348834	288.188	0.310333	293.859	0.242651	308.73	0.23946	307.587
0.349771	288.144	0.311167	293.763	0.243304	308.655	0.240105	307.52
0.350707	288.1	0.312001	293.669	0.243957	308.575	0.240749	307.451
0.351643	288.058	0.312834	293.578	0.24461	308.492	0.241394	307.38
0.352579	288.016	0.313668	293.49	0.245263	308.406	0.242039	307.307
0.353516	287.975	0.314502	293.403	0.245916	308.317	0.242683	307.231
0.354452	287.935	0.315335	293.319	0.246569	308.225	0.243328	307.154
0.355388	287.895	0.316169	293.238	0.247221	308.13	0.243973	307.076
0.356324	287.856	0.317003	293.16	0.247874	308.033	0.244617	306.996
0.357261	287.817	0.317837	293.085	0.248527	307.934	0.245262	306.914
0.358197	287.779	0.31867	293.013	0.24918	307.832	0.245907	306.831
0.359133	287.742	0.319504	292.944	0.249833	307.729	0.246551	306.746

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.360069	287.705	0.320338	292.878	0.250486	307.624	0.247196	306.66
0.361006	287.669	0.321171	292.813	0.251139	307.516	0.247841	306.572
0.361942	287.633	0.322005	292.75	0.251792	307.407	0.248485	306.483
0.362878	287.597	0.322839	292.688	0.252445	307.296	0.24913	306.392
0.363814	287.562	0.323672	292.628	0.253097	307.183	0.249775	306.3
0.364751	287.528	0.324506	292.569	0.25375	307.069	0.250419	306.209
0.365687	287.494	0.32534	292.511	0.254403	306.952	0.251064	306.117
0.366623	287.46	0.326173	292.455	0.255056	306.834	0.251709	306.026
0.367559	287.426	0.327007	292.4	0.255709	306.715	0.252353	305.934
0.368496	287.393	0.327841	292.346	0.256362	306.596	0.252998	305.842
0.369432	287.36	0.328675	292.293	0.257015	306.475	0.253643	305.75
0.370368	287.328	0.329508	292.241	0.257668	306.354	0.254287	305.659
0.371304	287.295	0.330342	292.19	0.258321	306.232	0.254932	305.567
0.372241	287.263	0.331176	292.141	0.258974	306.11	0.255577	305.475
0.373177	287.231	0.332009	292.092	0.259626	305.987	0.256221	305.382
0.374113	287.199	0.332843	292.044	0.260279	305.864	0.256866	305.29
0.375049	287.168	0.333677	291.998	0.260932	305.741	0.257511	305.198
0.375986	287.137	0.33451	291.952	0.261585	305.617	0.258155	305.105
0.376922	287.106	0.335344	291.907	0.262238	305.494	0.2588	305.012
0.377858	287.075	0.336178	291.864	0.262891	305.371	0.259445	304.919
0.378794	287.044	0.337012	291.821	0.263544	305.248	0.260089	304.826
0.379731	287.014	0.337845	291.779	0.264197	305.125	0.260734	304.732
0.380667	286.983	0.338679	291.737	0.26485	305.004	0.261379	304.639
0.381603	286.953	0.339513	291.698	0.265503	304.882	0.262023	304.546
0.382539	286.923	0.340346	291.66	0.266155	304.762	0.262668	304.453
0.383476	286.893	0.34118	291.623	0.266808	304.642	0.263313	304.36
0.384412	286.863	0.342014	291.588	0.267461	304.524	0.263957	304.267
0.385348	286.833	0.342847	291.553	0.268114	304.406	0.264602	304.174
0.386285	286.804	0.343681	291.52	0.268767	304.289	0.265247	304.082
0.387221	286.774	0.344515	291.487	0.26942	304.174	0.265891	303.991
0.388157	286.745	0.345349	291.455	0.270073	304.059	0.266536	303.9
0.389093	286.716	0.346182	291.423	0.270726	303.946	0.267181	303.809
0.39003	286.686	0.347016	291.392	0.271379	303.834	0.267825	303.719
0.390966	286.657	0.34785	291.361	0.272031	303.722	0.26847	303.63
0.391902	286.628	0.348683	291.331	0.272684	303.613	0.269115	303.542
0.392838	286.599	0.349517	291.301	0.273337	303.504	0.269759	303.455
0.393775	286.57	0.350351	291.272	0.27399	303.397	0.270404	303.369
0.394711	286.541	0.351184	291.243	0.274643	303.291	0.271049	303.283
0.395647	286.513	0.352018	291.215	0.275296	303.186	0.271693	303.198
0.396583	286.484	0.352852	291.187	0.275949	303.082	0.272338	303.115
0.39752	286.455	0.353686	291.159	0.276602	302.981	0.272983	303.032
0.398456	286.427	0.354519	291.132	0.277255	302.88	0.273627	302.95
0.399392	286.398	0.355353	291.105	0.277908	302.781	0.274272	302.869

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.400328	286.369	0.356187	291.078	0.27856	302.683	0.274917	302.789
0.401265	286.341	0.35702	291.052	0.279213	302.588	0.275561	302.71
0.402201	286.313	0.357854	291.026	0.279866	302.493	0.276206	302.632
0.403137	286.285	0.358688	291	0.280519	302.4	0.276851	302.555
0.404073	286.257	0.359521	290.975	0.281172	302.309	0.277495	302.479
0.40501	286.229	0.360355	290.949	0.281825	302.219	0.27814	302.405
0.405946	286.201	0.361189	290.924	0.282478	302.132	0.278785	302.331
0.406882	286.173	0.362023	290.9	0.283131	302.045	0.279429	302.259
0.407818	286.144	0.362856	290.875	0.283784	301.96	0.280074	302.188
0.408755	286.116	0.36369	290.851	0.284436	301.877	0.280719	302.118
0.409691	286.088	0.364524	290.827	0.285089	301.796	0.281364	302.049
0.410627	286.06	0.365357	290.803	0.285742	301.716	0.282008	301.982
0.411563	286.032	0.366191	290.78	0.286395	301.637	0.282653	301.915
0.4125	286.004	0.367025	290.756	0.287048	301.56	0.283298	301.85
0.413436	285.976	0.367858	290.733	0.287701	301.485	0.283942	301.786
0.414372	285.949	0.368692	290.71	0.288354	301.411	0.284587	301.723
0.415308	285.921	0.369526	290.687	0.289007	301.338	0.285232	301.66
0.416245	285.893	0.37036	290.664	0.28966	301.267	0.285876	301.6
0.417181	285.866	0.371193	290.642	0.290312	301.197	0.286521	301.54
0.418117	285.838	0.372027	290.619	0.290965	301.129	0.287166	301.481
0.419053	285.81	0.372861	290.597	0.291618	301.062	0.28781	301.423
0.41999	285.782	0.373694	290.575	0.292271	300.996	0.288455	301.366
0.420926	285.755	0.374528	290.553	0.292924	300.932	0.2891	301.31
0.421862	285.727	0.375362	290.531	0.293577	300.868	0.289744	301.255
0.422798	285.699	0.376195	290.509	0.29423	300.806	0.290389	301.201
0.423735	285.671	0.377029	290.487	0.294883	300.745	0.291034	301.148
0.424671	285.644	0.377863	290.465	0.295536	300.686	0.291678	301.096
0.425607	285.616	0.378697	290.443	0.296189	300.627	0.292323	301.045
0.426543	285.589	0.37953	290.422	0.296841	300.57	0.292968	300.994
0.42748	285.561	0.380364	290.401	0.297494	300.513	0.293612	300.945
0.428416	285.534	0.381198	290.379	0.298147	300.458	0.294257	300.896
0.429352	285.506	0.382031	290.358	0.2988	300.404	0.294902	300.848
0.430288	285.479	0.382865	290.337	0.299453	300.351	0.295546	300.801
0.431225	285.451	0.383699	290.316	0.300106	300.299	0.296191	300.755
0.432161	285.424	0.384532	290.295	0.300759	300.248	0.296836	300.71
0.433097	285.396	0.385366	290.273	0.301412	300.198	0.29748	300.665
0.434033	285.368	0.3862	290.253	0.302065	300.148	0.298125	300.621
0.43497	285.341	0.387034	290.232	0.302717	300.1	0.29877	300.578
0.435906	285.313	0.387867	290.211	0.30337	300.053	0.299414	300.536
0.436842	285.285	0.388701	290.19	0.304023	300.006	0.300059	300.494
0.437778	285.258	0.389535	290.169	0.304676	299.96	0.300704	300.453
0.438715	285.23	0.390368	290.149	0.305329	299.915	0.301348	300.413
0.439651	285.203	0.391202	290.128	0.305982	299.871	0.301993	300.373

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.440587	285.175	0.392036	290.108	0.306635	299.828	0.302638	300.334
0.441524	285.148	0.392869	290.087	0.307288	299.785	0.303282	300.295
0.44246	285.12	0.393703	290.067	0.307941	299.743	0.303927	300.258
0.443396	285.092	0.394537	290.046	0.308594	299.702	0.304572	300.22
0.444332	285.064	0.39537	290.026	0.309246	299.661	0.305216	300.184
0.445269	285.037	0.396204	290.006	0.309899	299.621	0.305861	300.148
0.446205	285.009	0.397038	289.985	0.310552	299.582	0.306506	300.112
0.447141	284.981	0.397872	289.965	0.311205	299.543	0.30715	300.077
0.448077	284.953	0.398705	289.945	0.311858	299.505	0.307795	300.043
0.449014	284.925	0.399539	289.925	0.312511	299.467	0.30844	300.008
0.44995	284.897	0.400373	289.905	0.313164	299.43	0.309084	299.975
0.450886	284.869	0.401206	289.885	0.313817	299.393	0.309729	299.942
0.451822	284.841	0.40204	289.865	0.31447	299.357	0.310374	299.909
0.452759	284.813	0.402874	289.845	0.315122	299.321	0.311018	299.877
0.453695	284.785	0.403707	289.825	0.315775	299.286	0.311663	299.845
0.454631	284.757	0.404541	289.805	0.316428	299.251	0.312308	299.814
0.455567	284.729	0.405375	289.785	0.317081	299.216	0.312952	299.782
0.456504	284.701	0.406209	289.765	0.317734	299.182	0.313597	299.752
0.45744	284.673	0.407042	289.745	0.318387	299.149	0.314242	299.721
0.458376	284.645	0.407876	289.726	0.31904	299.116	0.314886	299.691
0.459312	284.617	0.40871	289.706	0.319693	299.083	0.315531	299.662
0.460249	284.589	0.409543	289.686	0.320346	299.05	0.316176	299.632
0.461185	284.56	0.410377	289.667	0.320999	299.018	0.31682	299.603
0.462121	284.532	0.411211	289.647	0.321651	298.987	0.317465	299.575
0.463057	284.504	0.412044	289.627	0.322304	298.955	0.31811	299.546
0.463994	284.475	0.412878	289.608	0.322957	298.924	0.318754	299.518
0.46493	284.447	0.413712	289.588	0.32361	298.893	0.319399	299.49
0.465866	284.418	0.414546	289.568	0.324263	298.863	0.320044	299.462
0.466802	284.39	0.415379	289.549	0.324916	298.833	0.320688	299.435
0.467739	284.362	0.416213	289.529	0.325569	298.803	0.321333	299.408
0.468675	284.333	0.417047	289.509	0.326222	298.773	0.321978	299.382
0.469611	284.305	0.41788	289.49	0.326875	298.744	0.322622	299.355
0.470547	284.276	0.418714	289.47	0.327527	298.714	0.323267	299.329
0.471484	284.247	0.419548	289.451	0.32818	298.686	0.323912	299.303
0.47242	284.219	0.420381	289.431	0.328833	298.657	0.324556	299.277
0.473356	284.19	0.421215	289.411	0.329486	298.629	0.325201	299.252
0.474292	284.161	0.422049	289.392	0.330139	298.601	0.325846	299.226
0.475229	284.133	0.422883	289.372	0.330792	298.573	0.32649	299.201
0.476165	284.104	0.423716	289.353	0.331445	298.545	0.327135	299.177
0.477101	284.075	0.42455	289.333	0.332098	298.518	0.32778	299.152
0.478037	284.046	0.425384	289.313	0.332751	298.49	0.328424	299.127
0.478974	284.017	0.426217	289.294	0.333404	298.463	0.329069	299.103
0.47991	283.988	0.427051	289.274	0.334056	298.436	0.329714	299.079

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.480846	283.959	0.427885	289.255	0.334709	298.409	0.330358	299.055
0.481782	283.93	0.428718	289.235	0.335362	298.383	0.331003	299.032
0.482719	283.901	0.429552	289.216	0.336015	298.356	0.331648	299.008
0.483655	283.872	0.430386	289.196	0.336668	298.329	0.332292	298.985
0.484591	283.843	0.43122	289.176	0.337321	298.303	0.332937	298.962
0.485527	283.813	0.432053	289.157	0.337974	298.277	0.333582	298.939
0.486464	283.784	0.432887	289.137	0.338627	298.251	0.334227	298.916
0.4874	283.755	0.433721	289.118	0.33928	298.225	0.334871	298.894
0.488336	283.726	0.434554	289.098	0.339932	298.199	0.335516	298.871
0.489272	283.696	0.435388	289.079	0.340585	298.174	0.336161	298.849
0.490209	283.667	0.436222	289.059	0.341238	298.148	0.336805	298.827
0.491145	283.637	0.437055	289.039	0.341891	298.123	0.33745	298.805
0.492081	283.608	0.437889	289.02	0.342544	298.098	0.338095	298.783
0.493017	283.578	0.438723	289	0.343197	298.074	0.338739	298.761
0.493954	283.549	0.439557	288.981	0.34385	298.049	0.339384	298.74
0.49489	283.519	0.44039	288.961	0.344503	298.024	0.340029	298.718
0.495826	283.49	0.441224	288.941	0.345156	298	0.340673	298.697
0.496762	283.46	0.442058	288.922	0.345809	297.976	0.341318	298.675
0.497699	283.431	0.442891	288.902	0.346461	297.952	0.341963	298.654
0.498635	283.401	0.443725	288.883	0.347114	297.928	0.342607	298.633
0.499571	283.371	0.444559	288.863	0.347767	297.904	0.343252	298.612
0.500508	283.342	0.445392	288.843	0.34842	297.88	0.343897	298.591
0.501444	283.312	0.446226	288.824	0.349073	297.856	0.344541	298.57
0.50238	283.282	0.44706	288.804	0.349726	297.833	0.345186	298.549
0.503316	283.252	0.447894	288.784	0.350379	297.809	0.345831	298.529
0.504253	283.223	0.448727	288.765	0.351032	297.786	0.346475	298.509
0.505189	283.193	0.449561	288.745	0.351685	297.763	0.34712	298.488
0.506125	283.163	0.450395	288.725	0.352337	297.74	0.347765	298.468
0.507061	283.133	0.451228	288.705	0.35299	297.717	0.348409	298.448
0.507998	283.103	0.452062	288.685	0.353643	297.694	0.349054	298.428
0.508934	283.073	0.452896	288.666	0.354296	297.671	0.349699	298.409
0.50987	283.043	0.453729	288.646	0.354949	297.648	0.350343	298.389
0.510806	283.013	0.454563	288.626	0.355602	297.625	0.350988	298.37
0.511743	282.983	0.455397	288.606	0.356255	297.603	0.351633	298.35
0.512679	282.953	0.456231	288.586	0.356908	297.58	0.352277	298.331
0.513615	282.924	0.457064	288.566	0.357561	297.558	0.352922	298.312
0.514551	282.894	0.457898	288.547	0.358213	297.535	0.353567	298.293
0.515488	282.864	0.458732	288.527	0.358866	297.513	0.354211	298.274
0.516424	282.834	0.459565	288.507	0.359519	297.491	0.354856	298.255
0.51736	282.804	0.460399	288.487	0.360172	297.469	0.355501	298.236
0.518296	282.774	0.461233	288.467	0.360825	297.447	0.356145	298.217
0.519233	282.744	0.462066	288.447	0.361478	297.425	0.35679	298.199
0.520169	282.714	0.4629	288.427	0.362131	297.403	0.357435	298.18

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.521105	282.684	0.463734	288.407	0.362784	297.381	0.358079	298.162
0.522041	282.654	0.464568	288.387	0.363437	297.359	0.358724	298.144
0.522978	282.624	0.465401	288.367	0.36409	297.338	0.359369	298.126
0.523914	282.594	0.466235	288.348	0.364742	297.316	0.360013	298.108
0.52485	282.564	0.467069	288.328	0.365395	297.295	0.360658	298.089
0.525786	282.534	0.467902	288.308	0.366048	297.273	0.361303	298.072
0.526723	282.504	0.468736	288.288	0.366701	297.252	0.361947	298.054
0.527659	282.474	0.46957	288.268	0.367354	297.231	0.362592	298.036
0.528595	282.444	0.470403	288.248	0.368007	297.21	0.363237	298.018
0.529531	282.414	0.471237	288.228	0.36866	297.189	0.363881	298
0.530468	282.384	0.472071	288.208	0.369313	297.168	0.364526	297.983
0.531404	282.354	0.472905	288.188	0.369966	297.147	0.365171	297.965
0.53234	282.324	0.473738	288.168	0.370618	297.126	0.365815	297.948
0.533276	282.294	0.474572	288.148	0.371271	297.105	0.36646	297.93
0.534213	282.264	0.475406	288.128	0.371924	297.085	0.367105	297.913
0.535149	282.234	0.476239	288.108	0.372577	297.064	0.367749	297.895
0.536085	282.204	0.477073	288.089	0.37323	297.043	0.368394	297.878
0.537021	282.174	0.477907	288.069	0.373883	297.023	0.369039	297.861
0.537958	282.144	0.47874	288.049	0.374536	297.002	0.369683	297.844
0.538894	282.114	0.479574	288.029	0.375189	296.982	0.370328	297.827
0.53983	282.084	0.480408	288.008	0.375842	296.961	0.370973	297.81
0.540766	282.054	0.481242	287.988	0.376494	296.941	0.371617	297.793
0.541703	282.024	0.482075	287.968	0.377147	296.921	0.372262	297.776
0.542639	281.994	0.482909	287.948	0.3778	296.9	0.372907	297.759
0.543575	281.964	0.483743	287.928	0.378453	296.88	0.373551	297.742
0.544511	281.934	0.484576	287.908	0.379106	296.86	0.374196	297.726
0.545448	281.904	0.48541	287.888	0.379759	296.84	0.374841	297.709
0.546384	281.875	0.486244	287.868	0.380412	296.82	0.375485	297.693
0.54732	281.845	0.487077	287.848	0.381065	296.8	0.37613	297.676
0.548256	281.815	0.487911	287.828	0.381718	296.78	0.376775	297.66
0.549193	281.785	0.488745	287.808	0.382371	296.76	0.377419	297.644
0.550129	281.755	0.489579	287.788	0.383023	296.74	0.378064	297.627
0.551065	281.725	0.490412	287.768	0.383676	296.72	0.378709	297.611
0.552002	281.695	0.491246	287.748	0.384329	296.7	0.379353	297.595
0.552938	281.665	0.49208	287.728	0.384982	296.68	0.379998	297.579
0.553874	281.635	0.492913	287.708	0.385635	296.661	0.380643	297.563
0.55481	281.605	0.493747	287.688	0.386288	296.641	0.381287	297.547
0.555747	281.575	0.494581	287.668	0.386941	296.622	0.381932	297.532
0.556683	281.545	0.495414	287.649	0.387594	296.602	0.382577	297.516
0.557619	281.515	0.496248	287.629	0.388247	296.583	0.383221	297.5
0.558555	281.485	0.497082	287.609	0.388899	296.564	0.383866	297.485
0.559492	281.454	0.497916	287.589	0.389552	296.544	0.384511	297.469
0.560428	281.424	0.498749	287.569	0.390205	296.525	0.385155	297.454

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.561364	281.394	0.499583	287.55	0.390858	296.506	0.3858	297.438
0.5623	281.364	0.500417	287.53	0.391511	296.487	0.386445	297.423
0.563237	281.334	0.50125	287.51	0.392164	296.468	0.387089	297.408
0.564173	281.304	0.502084	287.49	0.392817	296.449	0.387734	297.393
0.565109	281.274	0.502918	287.471	0.39347	296.43	0.388379	297.378
0.566045	281.243	0.503751	287.451	0.394123	296.411	0.389023	297.363
0.566982	281.213	0.504585	287.431	0.394776	296.393	0.389668	297.348
0.567918	281.183	0.505419	287.412	0.395428	296.374	0.390313	297.334
0.568854	281.153	0.506253	287.392	0.396081	296.355	0.390957	297.319
0.56979	281.123	0.507086	287.372	0.396734	296.336	0.391602	297.305
0.570727	281.093	0.50792	287.353	0.397387	296.318	0.392247	297.29
0.571663	281.063	0.508754	287.333	0.39804	296.299	0.392891	297.276
0.572599	281.033	0.509587	287.314	0.398693	296.281	0.393536	297.262
0.573535	281.003	0.510421	287.294	0.399346	296.263	0.394181	297.247
0.574472	280.973	0.511255	287.275	0.399999	296.244	0.394826	297.233
0.575408	280.943	0.512088	287.255	0.400652	296.226	0.39547	297.219
0.576344	280.913	0.512922	287.236	0.401304	296.208	0.396115	297.205
0.57728	280.883	0.513756	287.216	0.401957	296.19	0.39676	297.191
0.578217	280.853	0.51459	287.197	0.40261	296.172	0.397404	297.177
0.579153	280.823	0.515423	287.177	0.403263	296.154	0.398049	297.163
0.580089	280.793	0.516257	287.158	0.403916	296.136	0.398694	297.149
0.581025	280.763	0.517091	287.139	0.404569	296.118	0.399338	297.136
0.581962	280.733	0.517924	287.119	0.405222	296.101	0.399983	297.122
0.582898	280.704	0.518758	287.1	0.405875	296.084	0.400628	297.109
0.583834	280.674	0.519592	287.08	0.406528	296.067	0.401272	297.095
0.58477	280.644	0.520425	287.061	0.407181	296.05	0.401917	297.082
0.585707	280.614	0.521259	287.042	0.407833	296.033	0.402562	297.069
0.586643	280.585	0.522093	287.022	0.408486	296.016	0.403206	297.055
0.587579	280.555	0.522927	287.003	0.409139	295.999	0.403851	297.043
0.588515	280.526	0.52376	286.983	0.409792	295.982	0.404496	297.03
0.589452	280.496	0.524594	286.964	0.410445	295.966	0.40514	297.017
0.590388	280.467	0.525428	286.944	0.411098	295.949	0.405785	297.004
0.591324	280.437	0.526261	286.924	0.411751	295.933	0.40643	296.992
0.59226	280.408	0.527095	286.905	0.412404	295.916	0.407074	296.979
0.593197	280.378	0.527929	286.885	0.413057	295.9	0.407719	296.967
0.594133	280.349	0.528762	286.865	0.413709	295.884	0.408364	296.955
0.595069	280.32	0.529596	286.845	0.414362	295.868	0.409008	296.943
0.596005	280.29	0.53043	286.825	0.415015	295.852	0.409653	296.931
0.596942	280.261	0.531264	286.805	0.415668	295.836	0.410298	296.918
0.597878	280.232	0.532097	286.785	0.416321	295.82	0.410942	296.906
0.598814	280.202	0.532931	286.764	0.416974	295.804	0.411587	296.894
0.59975	280.173	0.533765	286.744	0.417627	295.788	0.412232	296.882
0.600687	280.144	0.534598	286.724	0.41828	295.772	0.412876	296.87

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.601623	280.115	0.535432	286.703	0.418933	295.757	0.413521	296.859
0.602559	280.086	0.536266	286.682	0.419586	295.741	0.414166	296.847
0.603495	280.056	0.537099	286.661	0.420238	295.726	0.41481	296.835
0.604432	280.027	0.537933	286.64	0.420891	295.71	0.415455	296.823
0.605368	279.998	0.538767	286.62	0.421544	295.695	0.4161	296.812
0.606304	279.969	0.5396	286.598	0.422197	295.68	0.416744	296.8
0.60724	279.939	0.540434	286.577	0.42285	295.665	0.417389	296.789
0.608177	279.91	0.541268	286.556	0.423503	295.65	0.418034	296.777
0.609113	279.881	0.542102	286.535	0.424156	295.635	0.418678	296.766
0.610049	279.851	0.542935	286.513	0.424809	295.62	0.419323	296.755
0.610986	279.822	0.543769	286.492	0.425462	295.605	0.419968	296.744
0.611922	279.793	0.544603	286.47	0.426114	295.59	0.420612	296.732
0.612858	279.763	0.545436	286.449	0.426767	295.576	0.421257	296.721
0.613794	279.734	0.54627	286.427	0.42742	295.561	0.421902	296.71
0.614731	279.705	0.547104	286.405	0.428073	295.546	0.422546	296.699
0.615667	279.675	0.547937	286.383	0.428726	295.532	0.423191	296.688
0.616603	279.646	0.548771	286.361	0.429379	295.518	0.423836	296.677
0.617539	279.617	0.549605	286.339	0.430032	295.503	0.42448	296.667
0.618476	279.587	0.550439	286.317	0.430685	295.489	0.425125	296.656
0.619412	279.558	0.551272	286.295	0.431338	295.475	0.42577	296.645
0.620348	279.528	0.552106	286.273	0.431991	295.461	0.426414	296.634
0.621284	279.499	0.55294	286.25	0.432643	295.447	0.427059	296.623
0.622221	279.469	0.553773	286.228	0.433296	295.433	0.427704	296.613
0.623157	279.44	0.554607	286.205	0.433949	295.419	0.428348	296.602
0.624093	279.41	0.555441	286.182	0.434602	295.405	0.428993	296.592
0.625029	279.38	0.556274	286.159	0.435255	295.392	0.429638	296.581
0.625966	279.351	0.557108	286.136	0.435908	295.378	0.430282	296.57
0.626902	279.321	0.557942	286.113	0.436561	295.365	0.430927	296.56
0.627838	279.291	0.558776	286.09	0.437214	295.351	0.431572	296.55
0.628774	279.262	0.559609	286.066	0.437867	295.338	0.432216	296.539
0.629711	279.232	0.560443	286.043	0.438519	295.324	0.432861	296.529
0.630647	279.202	0.561277	286.019	0.439172	295.311	0.433506	296.519
0.631583	279.172	0.56211	285.995	0.439825	295.298	0.43415	296.508
0.632519	279.142	0.562944	285.971	0.440478	295.285	0.434795	296.498
0.633456	279.112	0.563778	285.947	0.441131	295.271	0.43544	296.488
0.634392	279.083	0.564611	285.923	0.441784	295.258	0.436084	296.478
0.635328	279.053	0.565445	285.899	0.442437	295.245	0.436729	296.468
0.636264	279.023	0.566279	285.874	0.44309	295.232	0.437374	296.458
0.637201	278.993	0.567113	285.849	0.443743	295.22	0.438018	296.448
0.638137	278.963	0.567946	285.824	0.444396	295.207	0.438663	296.437
0.639073	278.933	0.56878	285.799	0.445048	295.194	0.439308	296.427
0.640009	278.902	0.569614	285.774	0.445701	295.181	0.439952	296.417
0.640946	278.872	0.570447	285.749	0.446354	295.169	0.440597	296.408

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.641882	278.842	0.571281	285.724	0.447007	295.156	0.441242	296.398
0.642818	278.812	0.572115	285.698	0.44766	295.144	0.441886	296.388
0.643754	278.781	0.572948	285.672	0.448313	295.131	0.442531	296.378
0.644691	278.751	0.573782	285.647	0.448966	295.119	0.443176	296.368
0.645627	278.72	0.574616	285.621	0.449619	295.107	0.44382	296.358
0.646563	278.69	0.57545	285.595	0.450272	295.094	0.444465	296.348
0.647499	278.659	0.576283	285.568	0.450924	295.082	0.44511	296.339
0.648436	278.629	0.577117	285.542	0.451577	295.07	0.445754	296.329
0.649372	278.598	0.577951	285.516	0.45223	295.058	0.446399	296.319
0.650308	278.567	0.578784	285.489	0.452883	295.046	0.447044	296.31
0.651244	278.536	0.579618	285.462	0.453536	295.034	0.447689	296.3
0.652181	278.505	0.580452	285.436	0.454189	295.022	0.448333	296.29
0.653117	278.474	0.581285	285.409	0.454842	295.01	0.448978	296.281
0.654053	278.442	0.582119	285.382	0.455495	294.999	0.449623	296.271
0.654989	278.411	0.582953	285.355	0.456148	294.987	0.450267	296.262
0.655926	278.38	0.583787	285.328	0.4568	294.975	0.450912	296.252
0.656862	278.348	0.58462	285.301	0.457453	294.964	0.451557	296.243
0.657798	278.316	0.585454	285.273	0.458106	294.952	0.452201	296.233
0.658734	278.285	0.586288	285.246	0.458759	294.94	0.452846	296.224
0.659671	278.253	0.587121	285.219	0.459412	294.929	0.453491	296.215
0.660607	278.221	0.587955	285.191	0.460065	294.917	0.454135	296.205
0.661543	278.189	0.588789	285.164	0.460718	294.906	0.45478	296.196
0.662479	278.156	0.589622	285.136	0.461371	294.895	0.455425	296.187
0.663416	278.124	0.590456	285.109	0.462024	294.883	0.456069	296.177
0.664352	278.092	0.59129	285.081	0.462677	294.872	0.456714	296.168
0.665288	278.059	0.592124	285.053	0.463329	294.861	0.457359	296.159
0.666225	278.027	0.592957	285.025	0.463982	294.85	0.458003	296.149
0.667161	277.994	0.593791	284.998	0.464635	294.839	0.458648	296.14
0.668097	277.962	0.594625	284.97	0.465288	294.828	0.459293	296.131
0.669033	277.929	0.595458	284.942	0.465941	294.817	0.459937	296.122
0.669969	277.896	0.596292	284.914	0.466594	294.806	0.460582	296.112
0.670906	277.863	0.597126	284.886	0.467247	294.795	0.461227	296.103
0.671842	277.83	0.597959	284.858	0.4679	294.784	0.461871	296.094
0.672778	277.797	0.598793	284.83	0.468553	294.773	0.462516	296.085
0.673715	277.764	0.599627	284.802	0.469205	294.762	0.463161	296.076
0.674651	277.731	0.600461	284.775	0.469858	294.751	0.463805	296.067
0.675587	277.698	0.601294	284.747	0.470511	294.74	0.46445	296.058
0.676523	277.665	0.602128	284.719	0.471164	294.729	0.465095	296.049
0.67746	277.632	0.602962	284.691	0.471817	294.718	0.465739	296.04
0.678396	277.599	0.603795	284.663	0.47247	294.708	0.466384	296.03
0.679332	277.566	0.604629	284.635	0.473123	294.697	0.467029	296.021
0.680268	277.532	0.605463	284.607	0.473776	294.686	0.467673	296.012
0.681205	277.499	0.606296	284.579	0.474429	294.675	0.468318	296.003

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.682141	277.466	0.60713	284.551	0.475082	294.665	0.468963	295.994
0.683077	277.433	0.607964	284.524	0.475734	294.654	0.469607	295.985
0.684013	277.4	0.608798	284.496	0.476387	294.643	0.470252	295.977
0.68495	277.367	0.609631	284.468	0.47704	294.633	0.470897	295.968
0.685886	277.333	0.610465	284.441	0.477693	294.622	0.471541	295.959
0.686822	277.3	0.611299	284.413	0.478346	294.611	0.472186	295.95
0.687758	277.267	0.612132	284.386	0.478999	294.6	0.472831	295.941
0.688695	277.234	0.612966	284.359	0.479652	294.59	0.473475	295.932
0.689631	277.201	0.6138	284.332	0.480305	294.579	0.47412	295.923
0.690567	277.168	0.614633	284.305	0.480958	294.569	0.474765	295.914
0.691503	277.136	0.615467	284.278	0.48161	294.558	0.475409	295.905
0.69244	277.103	0.616301	284.251	0.482263	294.547	0.476054	295.896
0.693376	277.07	0.617135	284.225	0.482916	294.537	0.476699	295.888
0.694312	277.037	0.617968	284.198	0.483569	294.526	0.477343	295.879
0.695248	277.004	0.618802	284.172	0.484222	294.516	0.477988	295.87
0.696185	276.972	0.619636	284.146	0.484875	294.505	0.478633	295.861
0.697121	276.939	0.620469	284.12	0.485528	294.495	0.479277	295.853
0.698057	276.907	0.621303	284.095	0.486181	294.484	0.479922	295.844
0.698993	276.874	0.622137	284.069	0.486834	294.474	0.480567	295.835
0.69993	276.842	0.62297	284.044	0.487487	294.464	0.481211	295.826
0.700866	276.809	0.623804	284.019	0.488139	294.453	0.481856	295.817
0.701802	276.777	0.624638	283.995	0.488792	294.443	0.482501	295.809
0.702738	276.745	0.625472	283.97	0.489445	294.433	0.483145	295.8
0.703675	276.713	0.626305	283.946	0.490098	294.422	0.48379	295.791
0.704611	276.681	0.627139	283.922	0.490751	294.412	0.484435	295.783
0.705547	276.648	0.627973	283.898	0.491404	294.402	0.485079	295.774
0.706483	276.616	0.628806	283.875	0.492057	294.392	0.485724	295.765
0.70742	276.584	0.62964	283.852	0.49271	294.382	0.486369	295.757
0.708356	276.552	0.630474	283.829	0.493363	294.372	0.487013	295.748
0.709292	276.521	0.631307	283.806	0.494015	294.362	0.487658	295.739
0.710228	276.489	0.632141	283.784	0.494668	294.352	0.488303	295.73
0.711165	276.457	0.632975	283.761	0.495321	294.342	0.488947	295.721
0.712101	276.425	0.633809	283.739	0.495974	294.332	0.489592	295.713
0.713037	276.393	0.634642	283.718	0.496627	294.322	0.490237	295.704
0.713973	276.361	0.635476	283.696	0.49728	294.312	0.490881	295.695
0.71491	276.329	0.63631	283.675	0.497933	294.302	0.491526	295.687
0.715846	276.298	0.637143	283.654	0.498586	294.292	0.492171	295.678
0.716782	276.266	0.637977	283.633	0.499239	294.282	0.492815	295.669
0.717718	276.234	0.638811	283.613	0.499892	294.273	0.49346	295.661
0.718655	276.202	0.639644	283.593	0.500544	294.263	0.494105	295.652
0.719591	276.17	0.640478	283.573	0.501197	294.253	0.494749	295.643
0.720527	276.139	0.641312	283.553	0.50185	294.243	0.495394	295.634
0.721464	276.107	0.642146	283.533	0.502503	294.234	0.496039	295.626

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.7224	276.075	0.642979	283.514	0.503156	294.224	0.496683	295.617
0.723336	276.043	0.643813	283.495	0.503809	294.214	0.497328	295.608
0.724272	276.011	0.644647	283.476	0.504462	294.205	0.497973	295.599
0.725209	275.98	0.64548	283.457	0.505115	294.195	0.498617	295.591
0.726145	275.948	0.646314	283.439	0.505768	294.185	0.499262	295.582
0.727081	275.917	0.647148	283.421	0.50642	294.176	0.499907	295.573
0.728017	275.885	0.647981	283.403	0.507073	294.166	0.500551	295.564
0.728954	275.854	0.648815	283.385	0.507726	294.157	0.501196	295.555
0.72989	275.822	0.649649	283.367	0.508379	294.147	0.501841	295.547
0.730826	275.791	0.650483	283.35	0.509032	294.137	0.502486	295.538
0.731762	275.76	0.651316	283.332	0.509685	294.128	0.50313	295.529
0.732699	275.729	0.65215	283.315	0.510338	294.118	0.503775	295.52
0.733635	275.699	0.652984	283.298	0.510991	294.109	0.50442	295.512
0.734571	275.668	0.653817	283.281	0.511644	294.099	0.505064	295.503
0.735507	275.638	0.654651	283.265	0.512297	294.089	0.505709	295.494
0.736444	275.608	0.655485	283.249	0.512949	294.08	0.506354	295.485
0.73738	275.579	0.656318	283.232	0.513602	294.07	0.506998	295.476
0.738316	275.55	0.657152	283.216	0.514255	294.061	0.507643	295.468
0.739252	275.521	0.657986	283.2	0.514908	294.051	0.508288	295.459
0.740189	275.493	0.658819	283.185	0.515561	294.041	0.508932	295.45
0.741125	275.464	0.659653	283.169	0.516214	294.032	0.509577	295.441
0.742061	275.436	0.660487	283.153	0.516867	294.022	0.510222	295.432
0.742997	275.409	0.661321	283.138	0.51752	294.013	0.510866	295.423
0.743934	275.38	0.662154	283.123	0.518173	294.003	0.511511	295.414
0.74487	275.352	0.662988	283.108	0.518825	293.993	0.512156	295.405
0.745806	275.323	0.663822	283.093	0.519478	293.984	0.5128	295.397
0.746742	275.293	0.664655	283.078	0.520131	293.974	0.513445	295.388
0.747647	275.26	0.665489	283.064	0.520784	293.964	0.51409	295.379
0.74844	275.228	0.666323	283.049	0.521437	293.955	0.514734	295.37
0.749099	275.198	0.667157	283.035	0.52209	293.945	0.515379	295.361
0.74962	275.172	0.66799	283.021	0.522743	293.935	0.516024	295.352
0.75	275.163	0.668824	283.007	0.523396	293.926	0.516668	295.344
		0.669658	282.993	0.524049	293.916	0.517313	295.335
		0.670491	282.979	0.524702	293.906	0.517958	295.326
		0.671325	282.965	0.525354	293.897	0.518602	295.317
		0.672159	282.951	0.526007	293.887	0.519247	295.308
		0.672992	282.938	0.52666	293.877	0.519892	295.299
		0.673826	282.924	0.527313	293.867	0.520536	295.29
		0.67466	282.911	0.527966	293.858	0.521181	295.281
		0.675494	282.897	0.528619	293.848	0.521826	295.272
		0.676327	282.884	0.529272	293.838	0.52247	295.264
		0.677161	282.871	0.529925	293.828	0.523115	295.255
		0.677995	282.858	0.530578	293.818	0.52376	295.246

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
		0.678828	282.845	0.53123	293.809	0.524404	295.237
		0.679662	282.832	0.531883	293.799	0.525049	295.228
		0.680496	282.819	0.532536	293.789	0.525694	295.219
		0.681329	282.806	0.533189	293.779	0.526338	295.211
		0.682163	282.793	0.533842	293.769	0.526983	295.202
		0.682997	282.78	0.534495	293.76	0.527628	295.193
		0.68383	282.768	0.535148	293.75	0.528272	295.184
		0.684664	282.755	0.535801	293.74	0.528917	295.175
		0.685498	282.742	0.536454	293.73	0.529562	295.166
		0.686332	282.73	0.537106	293.72	0.530206	295.157
		0.687165	282.717	0.537759	293.711	0.530851	295.148
		0.687999	282.705	0.538412	293.701	0.531496	295.139
		0.688833	282.692	0.539065	293.691	0.53214	295.13
		0.689666	282.679	0.539718	293.681	0.532785	295.121
		0.6905	282.667	0.540371	293.672	0.53343	295.112
		0.691334	282.654	0.541024	293.662	0.534074	295.103
		0.692167	282.642	0.541677	293.652	0.534719	295.094
		0.693001	282.629	0.54233	293.642	0.535364	295.085
		0.693835	282.616	0.542983	293.633	0.536008	295.076
		0.694669	282.604	0.543635	293.623	0.536653	295.067
		0.695502	282.591	0.544288	293.613	0.537298	295.058
		0.696336	282.579	0.544941	293.603	0.537942	295.049
		0.69717	282.566	0.545594	293.593	0.538587	295.04
		0.698003	282.553	0.546247	293.584	0.539232	295.031
		0.698837	282.541	0.5469	293.574	0.539876	295.022
		0.699671	282.528	0.547553	293.564	0.540521	295.013
		0.700504	282.515	0.548206	293.554	0.541166	295.004
		0.701338	282.502	0.548859	293.544	0.54181	294.995
		0.702172	282.49	0.549511	293.535	0.542455	294.985
		0.703006	282.477	0.550164	293.525	0.5431	294.976
		0.703839	282.464	0.550817	293.515	0.543744	294.967
		0.704673	282.451	0.55147	293.505	0.544389	294.958
		0.705507	282.438	0.552123	293.495	0.545034	294.949
		0.70634	282.425	0.552776	293.485	0.545678	294.94
		0.707174	282.412	0.553429	293.475	0.546323	294.931
		0.708008	282.399	0.554082	293.465	0.546968	294.922
		0.708841	282.386	0.554735	293.455	0.547612	294.913
		0.709675	282.373	0.555388	293.445	0.548257	294.904
		0.710509	282.36	0.55604	293.435	0.548902	294.895
		0.711343	282.347	0.556693	293.425	0.549546	294.886
		0.712176	282.334	0.557346	293.415	0.550191	294.876
		0.71301	282.32	0.557999	293.405	0.550836	294.867
		0.713844	282.307	0.558652	293.395	0.55148	294.858

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
		0.714677	282.293	0.559305	293.385	0.552125	294.849
		0.715511	282.28	0.559958	293.375	0.55277	294.84
		0.716345	282.266	0.560611	293.365	0.553414	294.831
		0.717178	282.253	0.561264	293.355	0.554059	294.822
		0.718012	282.239	0.561916	293.345	0.554704	294.813
		0.718846	282.225	0.562569	293.335	0.555349	294.803
		0.71968	282.211	0.563222	293.325	0.555993	294.794
		0.720513	282.197	0.563875	293.315	0.556638	294.785
		0.721347	282.183	0.564528	293.305	0.557283	294.776
		0.722181	282.169	0.565181	293.295	0.557927	294.766
		0.723014	282.155	0.565834	293.285	0.558572	294.757
		0.723848	282.141	0.566487	293.275	0.559217	294.748
		0.724682	282.126	0.56714	293.265	0.559861	294.739
		0.725515	282.112	0.567793	293.255	0.560506	294.73
		0.726349	282.098	0.568445	293.245	0.561151	294.721
		0.727183	282.083	0.569098	293.235	0.561795	294.712
		0.728017	282.068	0.569751	293.225	0.56244	294.702
		0.72885	282.054	0.570404	293.215	0.563085	294.693
		0.729684	282.039	0.571057	293.205	0.563729	294.684
		0.730518	282.024	0.57171	293.195	0.564374	294.675
		0.731351	282.009	0.572363	293.185	0.565019	294.666
		0.732185	281.994	0.573016	293.175	0.565663	294.657
		0.733019	281.979	0.573669	293.166	0.566308	294.647
		0.733852	281.964	0.574321	293.156	0.566953	294.638
		0.734686	281.948	0.574974	293.146	0.567597	294.629
		0.73552	281.933	0.575627	293.136	0.568242	294.62
		0.736354	281.917	0.57628	293.126	0.568887	294.61
		0.737187	281.901	0.576933	293.117	0.569531	294.601
		0.738021	281.885	0.577586	293.107	0.570176	294.592
		0.738855	281.869	0.578239	293.097	0.570821	294.582
		0.739688	281.852	0.578892	293.087	0.571465	294.573
		0.740522	281.835	0.579545	293.078	0.57211	294.564
		0.741356	281.817	0.580198	293.068	0.572755	294.554
		0.742189	281.799	0.58085	293.058	0.573399	294.545
		0.743023	281.78	0.581503	293.048	0.574044	294.536
		0.743857	281.76	0.582156	293.038	0.574689	294.526
		0.744691	281.739	0.582809	293.028	0.575333	294.517
		0.745524	281.716	0.583462	293.018	0.575978	294.508
		0.746358	281.69	0.584115	293.008	0.576623	294.498
		0.747192	281.66	0.584768	292.997	0.577267	294.489
		0.747976	281.628	0.585421	292.987	0.577912	294.48
		0.748664	281.596	0.586074	292.977	0.578557	294.47
		0.749247	281.568	0.586726	292.966	0.579201	294.461

Mesh 5		Mesh 6		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
		0.749709	281.544	0.587379	292.956	0.579846	294.451
		0.75	281.537	0.588032	292.946	0.580491	294.442
				0.588685	292.935	0.581135	294.433
				0.589338	292.924	0.58178	294.423
				0.589991	292.914	0.582425	294.414
				0.590644	292.903	0.583069	294.405
				0.591297	292.893	0.583714	294.396
				0.59195	292.882	0.584359	294.386
				0.592603	292.871	0.585003	294.377
				0.593255	292.86	0.585648	294.368
				0.593908	292.85	0.586293	294.358
				0.594561	292.839	0.586937	294.349
				0.595214	292.828	0.587582	294.34
				0.595867	292.817	0.588227	294.33
				0.59652	292.806	0.588871	294.321
				0.597173	292.796	0.589516	294.312
				0.597826	292.785	0.590161	294.302
				0.598479	292.774	0.590805	294.293
				0.599131	292.763	0.59145	294.284
				0.599784	292.752	0.592095	294.274
				0.600437	292.741	0.592739	294.265
				0.60109	292.731	0.593384	294.256
				0.601743	292.72	0.594029	294.246
				0.602396	292.709	0.594673	294.237
				0.603049	292.698	0.595318	294.228
				0.603702	292.687	0.595963	294.219
				0.604355	292.676	0.596607	294.209
				0.605007	292.666	0.597252	294.2
				0.60566	292.655	0.597897	294.191
				0.606313	292.644	0.598541	294.182
				0.606966	292.633	0.599186	294.172
				0.607619	292.622	0.599831	294.163
				0.608272	292.612	0.600475	294.154
				0.608925	292.601	0.60112	294.145
				0.609578	292.59	0.601765	294.136
				0.610231	292.579	0.602409	294.127
				0.610884	292.568	0.603054	294.118
				0.611536	292.557	0.603699	294.109
				0.612189	292.547	0.604343	294.1
				0.612842	292.536	0.604988	294.091
				0.613495	292.525	0.605633	294.082
				0.614148	292.514	0.606277	294.073
				0.614801	292.503	0.606922	294.064

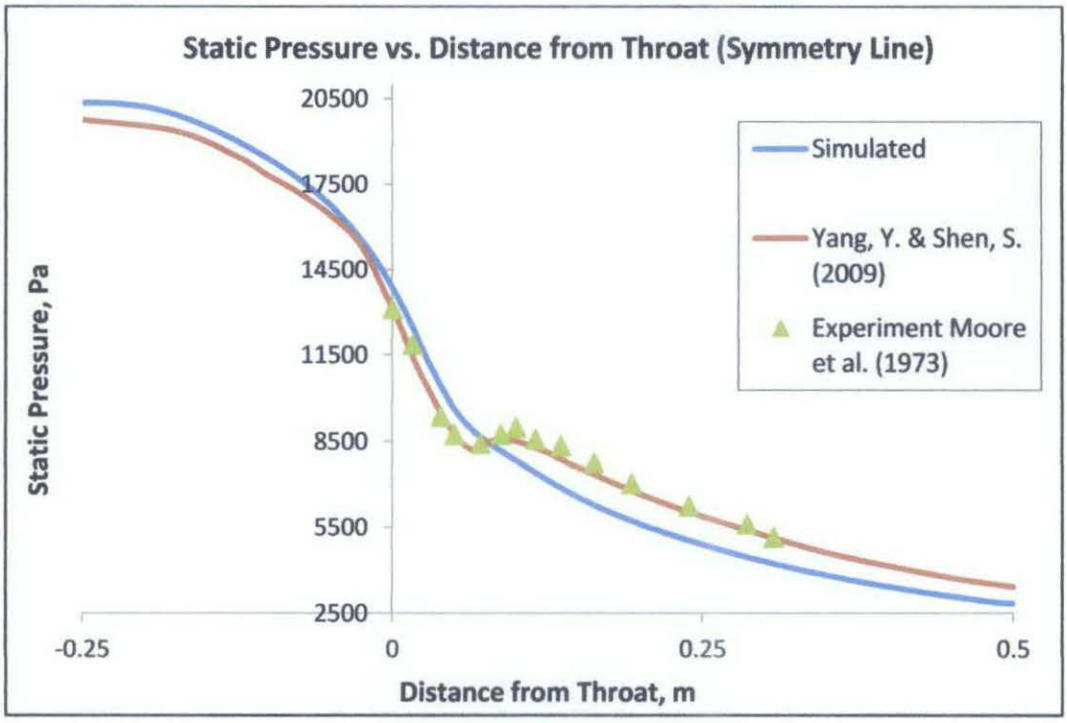
Mesh 7		Mesh 8		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.615454	292.493	0.607567	294.056	0.643528	292.033	0.635288	293.654
0.616107	292.482	0.608211	294.047	0.644181	292.022	0.635932	293.644
0.61676	292.471	0.608856	294.038	0.644834	292.01	0.636577	293.634
0.617413	292.461	0.609501	294.029	0.645487	291.999	0.637222	293.624
0.618065	292.45	0.610146	294.02	0.64614	291.988	0.637866	293.614
0.618718	292.439	0.61079	294.01	0.646793	291.977	0.638511	293.604
0.619371	292.429	0.611435	294.001	0.647446	291.965	0.639156	293.594
0.620024	292.418	0.61208	293.992	0.648099	291.954	0.6398	293.584
0.620677	292.408	0.612724	293.983	0.648751	291.943	0.640445	293.574
0.62133	292.397	0.613369	293.974	0.649404	291.932	0.64109	293.564
0.621983	292.387	0.614014	293.965	0.650057	291.921	0.641734	293.554
0.622636	292.376	0.614658	293.956	0.65071	291.91	0.642379	293.543
0.623289	292.366	0.615303	293.947	0.651363	291.899	0.643024	293.533
0.623941	292.355	0.615948	293.938	0.652016	291.889	0.643668	293.523
0.624594	292.345	0.616592	293.929	0.652669	291.878	0.644313	293.513
0.625247	292.335	0.617237	293.919	0.653322	291.867	0.644958	293.502
0.6259	292.324	0.617882	293.91	0.653975	291.857	0.645602	293.492
0.626553	292.314	0.618526	293.901	0.654627	291.846	0.646247	293.481
0.627206	292.304	0.619171	293.892	0.65528	291.836	0.646892	293.471
0.627859	292.294	0.619816	293.882	0.655933	291.826	0.647536	293.46
0.628512	292.284	0.62046	293.873	0.656586	291.815	0.648181	293.45
0.629165	292.273	0.621105	293.864	0.657239	291.805	0.648826	293.439
0.629817	292.263	0.62175	293.854	0.657892	291.795	0.64947	293.429
0.63047	292.253	0.622394	293.845	0.658545	291.785	0.650115	293.418
0.631123	292.242	0.623039	293.836	0.659198	291.775	0.65076	293.407
0.631776	292.232	0.623684	293.826	0.659851	291.765	0.651404	293.397
0.632429	292.221	0.624328	293.817	0.660504	291.755	0.652049	293.386
0.633082	292.211	0.624973	293.808	0.661156	291.745	0.652694	293.375
0.633735	292.2	0.625618	293.798	0.661809	291.735	0.653338	293.364
0.634388	292.19	0.626262	293.789	0.662462	291.725	0.653983	293.354
0.635041	292.179	0.626907	293.779	0.663115	291.714	0.654628	293.343
0.635694	292.168	0.627552	293.77	0.663768	291.704	0.655272	293.332
0.636346	292.157	0.628196	293.76	0.664421	291.694	0.655917	293.321
0.636999	292.146	0.628841	293.751	0.665074	291.684	0.656562	293.31
0.637652	292.135	0.629486	293.741	0.665727	291.674	0.657206	293.3
0.638305	292.124	0.63013	293.732	0.66638	291.664	0.657851	293.289
0.638958	292.113	0.630775	293.722	0.667032	291.654	0.658496	293.278
0.639611	292.102	0.63142	293.713	0.667685	291.644	0.65914	293.267
0.640264	292.09	0.632064	293.703	0.668338	291.633	0.659785	293.256
0.640917	292.079	0.632709	293.693	0.668991	291.623	0.66043	293.245
0.64157	292.068	0.633354	293.684	0.669644	291.613	0.661074	293.234
0.642222	292.056	0.633998	293.674	0.670297	291.603	0.661719	293.223
0.642875	292.045	0.634643	293.664	0.67095	291.592	0.662364	293.212

Mesh 7		Mesh 8		Mesh 7		Mesh 8	
x	y	x	y	x	y	x	y
0.671603	291.582	0.663009	293.201	0.699677	291.146	0.690729	292.711
0.672256	291.572	0.663653	293.189	0.70033	291.135	0.691374	292.7
0.672909	291.562	0.664298	293.178	0.700983	291.124	0.692019	292.689
0.673561	291.551	0.664943	293.167	0.701636	291.113	0.692663	292.677
0.674214	291.541	0.665587	293.155	0.702289	291.102	0.693308	292.666
0.674867	291.531	0.666232	293.144	0.702942	291.091	0.693953	292.655
0.67552	291.521	0.666877	293.133	0.703595	291.08	0.694597	292.644
0.676173	291.511	0.667521	293.121	0.704247	291.069	0.695242	292.633
0.676826	291.501	0.668166	293.11	0.7049	291.058	0.695887	292.622
0.677479	291.491	0.668811	293.099	0.705553	291.048	0.696531	292.611
0.678132	291.481	0.669455	293.087	0.706206	291.037	0.697176	292.6
0.678785	291.471	0.6701	293.076	0.706859	291.026	0.697821	292.589
0.679437	291.461	0.670745	293.064	0.707512	291.015	0.698465	292.578
0.68009	291.451	0.671389	293.053	0.708165	291.005	0.69911	292.567
0.680743	291.441	0.672034	293.042	0.708818	290.994	0.699755	292.556
0.681396	291.431	0.672679	293.03	0.709471	290.984	0.700399	292.546
0.682049	291.421	0.673323	293.019	0.710123	290.973	0.701044	292.535
0.682702	291.411	0.673968	293.007	0.710776	290.963	0.701689	292.524
0.683355	291.402	0.674613	292.996	0.711429	290.953	0.702333	292.514
0.684008	291.392	0.675257	292.984	0.712082	290.943	0.702978	292.503
0.684661	291.382	0.675902	292.973	0.712735	290.932	0.703623	292.493
0.685313	291.372	0.676547	292.961	0.713388	290.922	0.704267	292.482
0.685966	291.363	0.677191	292.95	0.714041	290.912	0.704912	292.472
0.686619	291.353	0.677836	292.939	0.714694	290.902	0.705557	292.462
0.687272	291.343	0.678481	292.927	0.715347	290.892	0.706201	292.452
0.687925	291.333	0.679125	292.916	0.716	290.882	0.706846	292.441
0.688578	291.324	0.67977	292.904	0.716652	290.873	0.707491	292.431
0.689231	291.314	0.680415	292.893	0.717305	290.863	0.708135	292.421
0.689884	291.304	0.681059	292.882	0.717958	290.853	0.70878	292.411
0.690537	291.294	0.681704	292.87	0.718611	290.843	0.709425	292.402
0.69119	291.284	0.682349	292.859	0.719264	290.834	0.710069	292.392
0.691842	291.274	0.682993	292.847	0.719917	290.824	0.710714	292.382
0.692495	291.264	0.683638	292.836	0.72057	290.815	0.711359	292.373
0.693148	291.254	0.684283	292.825	0.721223	290.805	0.712003	292.364
0.693801	291.244	0.684927	292.813	0.721876	290.796	0.712648	292.355
0.694454	291.233	0.685572	292.802	0.722528	290.786	0.713293	292.346
0.695107	291.223	0.686217	292.79	0.723181	290.777	0.713937	292.336
0.69576	291.212	0.686861	292.779	0.723834	290.768	0.714582	292.327
0.696413	291.201	0.687506	292.768	0.724487	290.758	0.715227	292.319
0.697066	291.19	0.688151	292.756	0.72514	290.749	0.715872	292.31
0.697719	291.18	0.688795	292.745	0.725793	290.74	0.716516	292.301
0.698371	291.169	0.68944	292.734	0.726446	290.73	0.717161	292.293
0.699024	291.158	0.690085	292.722	0.727099	290.721	0.717806	292.284

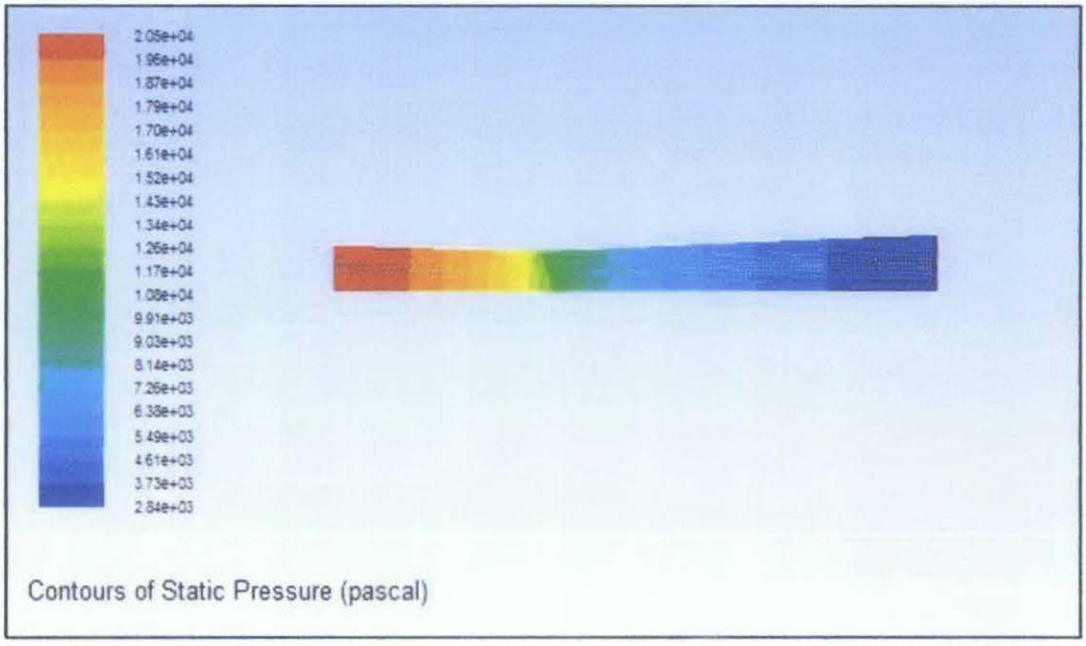
Mesh 7		Mesh 8		Mesh 8	
x	y	x	y	x	y
0.727752	290.712	0.71845	292.276	0.746171	291.995
0.728405	290.703	0.719095	292.267	0.746816	291.984
0.729057	290.694	0.71974	292.259	0.747452	291.97
0.72971	290.684	0.720384	292.251	0.748027	291.957
0.730363	290.675	0.721029	292.243	0.748529	291.944
0.731016	290.666	0.721674	292.236	0.748957	291.932
0.731669	290.657	0.722318	292.228	0.749324	291.921
0.732322	290.648	0.722963	292.22	0.749654	291.911
0.732975	290.638	0.723608	292.213	0.75	291.906
0.733628	290.629	0.724252	292.206		
0.734281	290.62	0.724897	292.199		
0.734933	290.611	0.725542	292.192		
0.735586	290.602	0.726186	292.185		
0.736239	290.592	0.726831	292.178		
0.736892	290.583	0.727476	292.171		
0.737545	290.574	0.72812	292.165		
0.738198	290.565	0.728765	292.158		
0.738851	290.555	0.72941	292.152		
0.739504	290.546	0.730054	292.146		
0.740157	290.537	0.730699	292.14		
0.74081	290.527	0.731344	292.134		
0.741462	290.518	0.731988	292.128		
0.742115	290.509	0.732633	292.122		
0.742768	290.499	0.733278	292.116		
0.743421	290.489	0.733922	292.111		
0.744074	290.48	0.734567	292.105		
0.744727	290.469	0.735212	292.1		
0.74538	290.459	0.735856	292.094		
0.746033	290.448	0.736501	292.089		
0.746686	290.436	0.737146	292.083		
0.747334	290.424	0.73779	292.078		
0.747944	290.41	0.738435	292.073		
0.748487	290.397	0.73908	292.067		
0.748954	290.386	0.739724	292.062		
0.749349	290.375	0.740369	292.057		
0.749689	290.365	0.741014	292.051		
0.75	290.36	0.741658	292.045		
		0.742303	292.04		
		0.742948	292.034		
		0.743592	292.028		
		0.744237	292.021		
		0.744882	292.014		
		0.745526	292.005		

APPENDIX V: HYDRODYNAMICS SIMULATION DATA

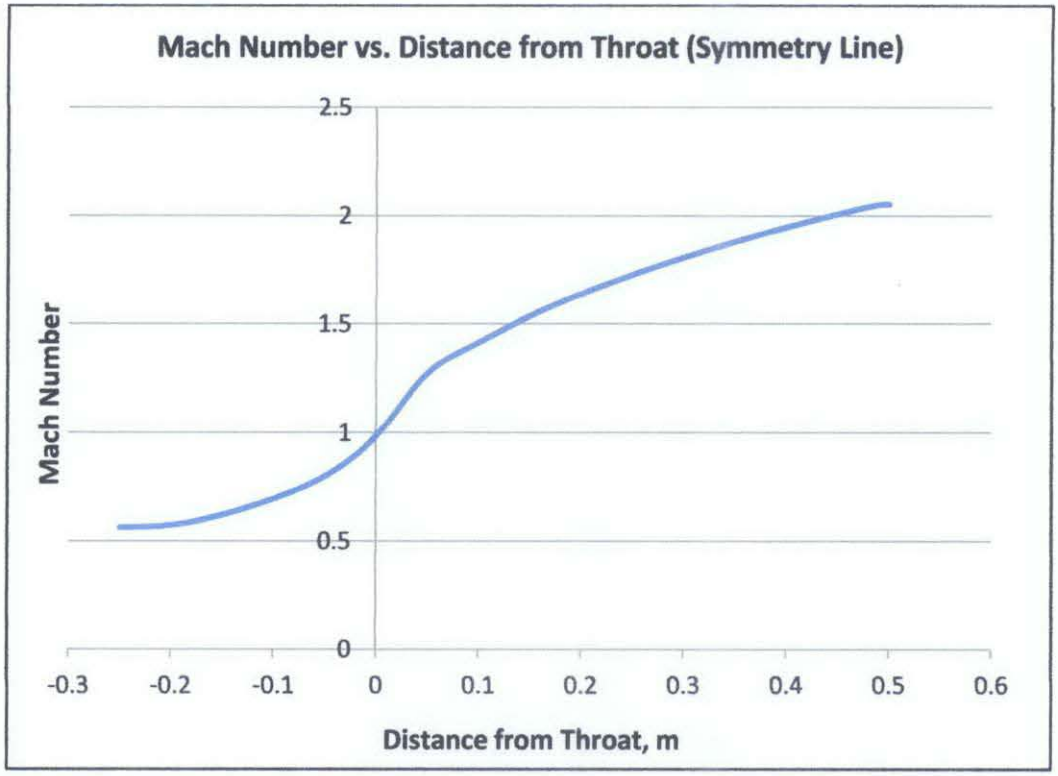
1. Validation Graph



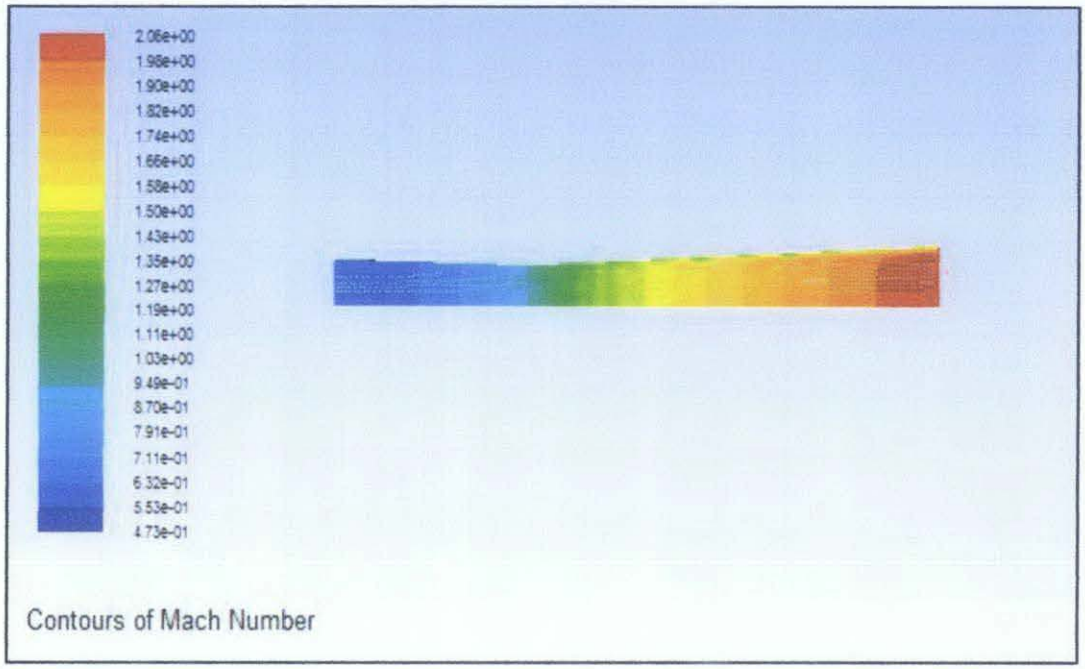
2. Contour Plot for Static Pressure – Validation Graph



3. Mach Number Profile Along Nozzle Symmetry



4. Contour Plot for Mach Profile

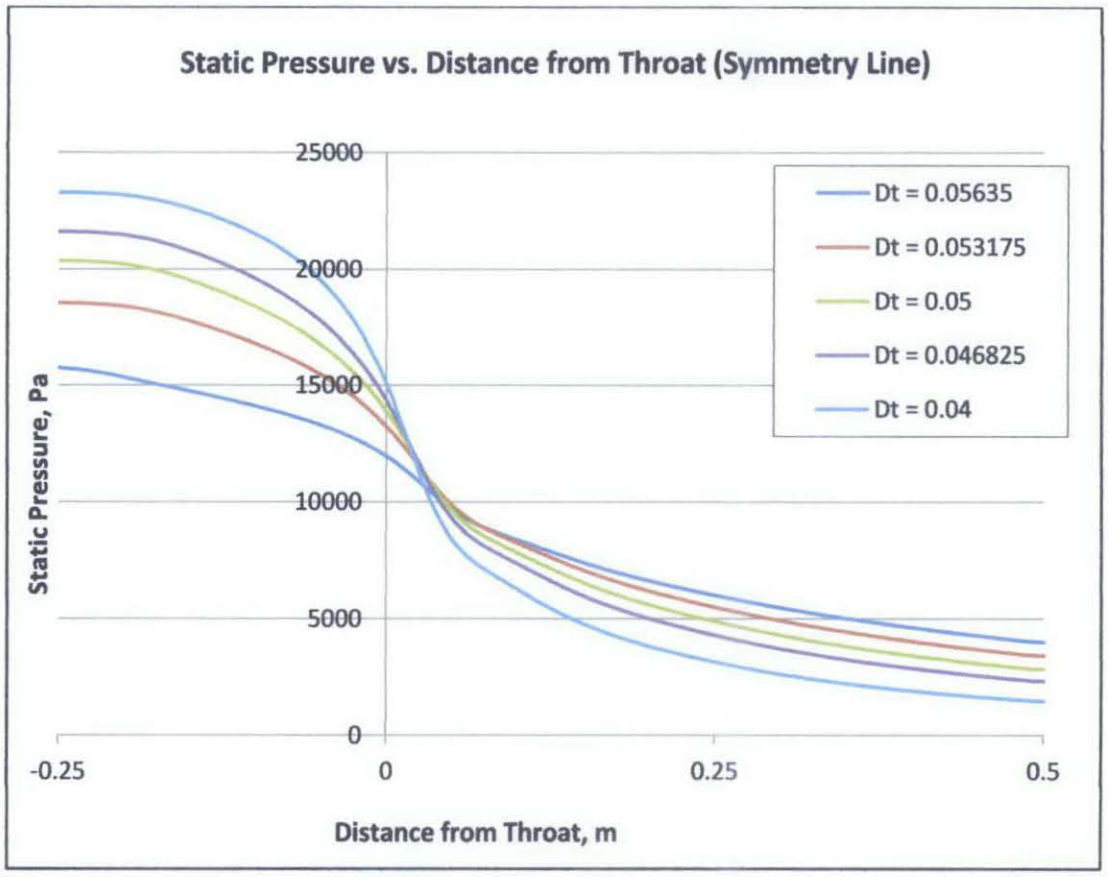


Simulated							
x	y	x	y	x	y	x	y
-0.25	20361.4	-0.07468	17660.8	0.104808	7706.44	0.284295	4486.53
-0.24776	20361.3	-0.07019	17511.5	0.109295	7585.32	0.288782	4436.06
-0.24519	20361	-0.06571	17355.9	0.113782	7464.36	0.293269	4386.51
-0.24071	20359.4	-0.06122	17193.4	0.118269	7344.08	0.297756	4337.86
-0.23622	20355.5	-0.05673	17023.4	0.122756	7225.05	0.302244	4290.11
-0.23173	20349.5	-0.05224	16845.3	0.127244	7107.82	0.306731	4243.24
-0.22724	20341	-0.04776	16658.3	0.131731	6992.86	0.311218	4197.25
-0.22276	20330.1	-0.04327	16461.7	0.136218	6880.57	0.315705	4152.12
-0.21827	20316.4	-0.03878	16254.5	0.140705	6771.24	0.320192	4107.83
-0.21378	20299.5	-0.03429	16035.7	0.145192	6665.06	0.324679	4064.37
-0.2093	20278.9	-0.02981	15804.5	0.149679	6562.17	0.329167	4021.7
-0.20481	20254.1	-0.02532	15559.6	0.154167	6462.61	0.333654	3979.82
-0.20032	20224.5	-0.02083	15300	0.158654	6366.35	0.338141	3938.69
-0.19583	20189.5	-0.01635	15024.7	0.163141	6273.34	0.342628	3898.3
-0.19135	20148.7	-0.01186	14732.9	0.167628	6183.46	0.347115	3858.61
-0.18686	20102.1	-0.00737	14423.7	0.172115	6096.59	0.351603	3819.62
-0.18237	20049.8	-0.00288	14096.4	0.176603	6012.55	0.35609	3781.29
-0.17789	19992.2	0.001603	13750.5	0.18109	5931.19	0.360577	3743.6
-0.1734	19929.3	0.00609	13384.9	0.185577	5852.31	0.365064	3706.53
-0.16891	19860.8	0.010577	12995.9	0.190064	5775.74	0.369551	3670.06
-0.16442	19787.4	0.015064	12584.6	0.194551	5701.29	0.374038	3634.17
-0.15994	19710.1	0.019551	12160.6	0.199038	5628.79	0.378526	3598.84
-0.15545	19629.6	0.024039	11734.3	0.203526	5558.07	0.383013	3564.05
-0.15096	19546.3	0.028526	11315.5	0.208013	5488.99	0.3875	3529.79
-0.14647	19460.2	0.033013	10912.7	0.2125	5421.4	0.391987	3496.05
-0.14199	19371.6	0.0375	10532.9	0.216987	5355.18	0.396474	3462.79
-0.1375	19280.4	0.041987	10181.5	0.221474	5290.23	0.400962	3430.03
-0.13301	19186.5	0.046474	9862.08	0.225962	5226.46	0.405449	3397.73
-0.12853	19089.9	0.050962	9576.2	0.230449	5163.79	0.409936	3365.9
-0.12404	18990.5	0.055449	9323.51	0.234936	5102.17	0.414423	3334.52
-0.11955	18888.2	0.059936	9101.89	0.239423	5041.56	0.41891	3303.59
-0.11506	18782.8	0.064423	8907.85	0.24391	4981.9	0.423397	3273.09
-0.11058	18674.1	0.06891	8736.93	0.248397	4923.19	0.427885	3243.02
-0.10609	18562	0.073397	8584.25	0.252885	4865.41	0.432372	3213.37
-0.1016	18446.3	0.077885	8445.02	0.257372	4808.54	0.436859	3184.14
-0.09712	18326.7	0.082372	8314.89	0.261859	4752.59	0.441346	3155.32
-0.09263	18203	0.086859	8190.31	0.266346	4697.55	0.445833	3126.91
-0.08814	18074.9	0.091346	8068.58	0.270833	4643.42	0.450321	3098.9
-0.08365	17942	0.095833	7947.93	0.275321	4590.21	0.454808	3071.29
-0.07917	17804.2	0.100321	7827.34	0.279808	4537.91	0.459295	3044.08

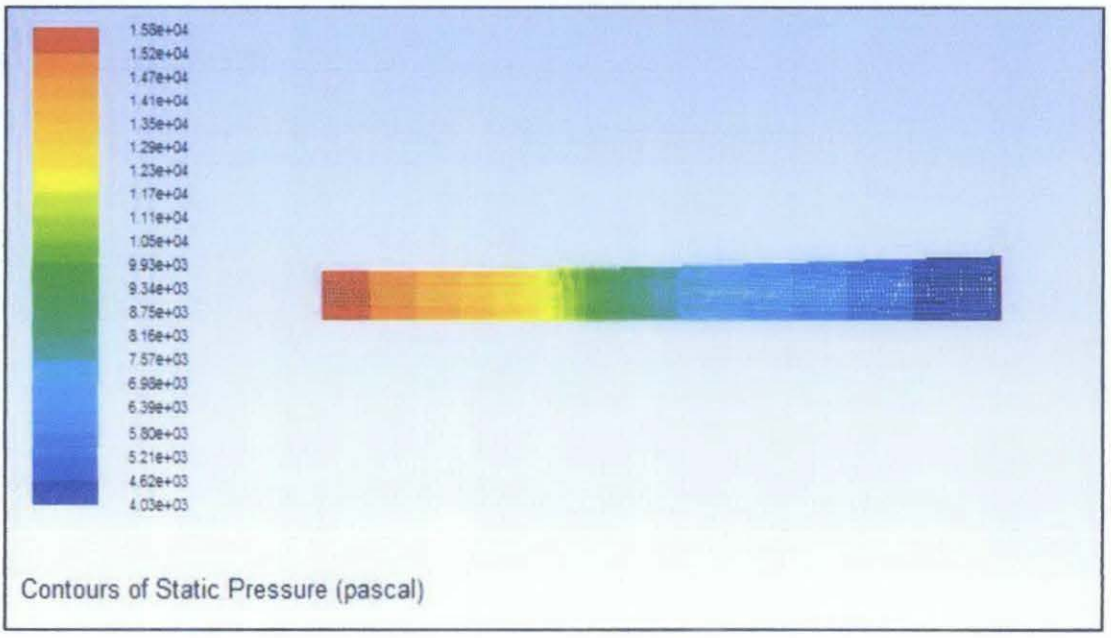
Simulated		Yang, Y. & Shen, S. (2009)		Experiment Moore et al. (1973)	
x	y	x	y	x	y
0.463782	3017.27	-0.25	19765	0	13125
0.468269	2990.87	-0.175	19375	0.0166	11875
0.472756	2964.91	-0.125	18482.5	0.039	9375
0.477244	2939.49	-0.1	17812.5	0.05	8750
0.481731	2914.81	-0.075	17187.5	0.071	8437.5
0.486218	2891.4	-0.05	16407.5	0.0875	8750
0.490705	2870.44	-0.025	15312.5	0.1	9000
0.495192	2855.74	0	13125	0.1154	8592.5
0.497756	2848.44	0.025	10625	0.1357	8360
0.5	2846.19	0.05	8750	0.1625	7767.5
		0.0625	8250	0.1929	7032.5
		0.0708	8281.25	0.239	6250
		0.075	8437.5	0.2857	5625
		0.0875	8625	0.30714	5156.25
		0.0875	8593.75		
		0.0929	8593.75		
		0.1	8515		
		0.125	8125		
		0.15	7590		
		0.225	6250		
		0.325	4910		
		0.375	4375		
		0.45	3750		
		0.5	3437.5		

APPENDIX VI: MANIPULATED VARIABLE – THROAT DIAMETER (STATIC PRESSURE)

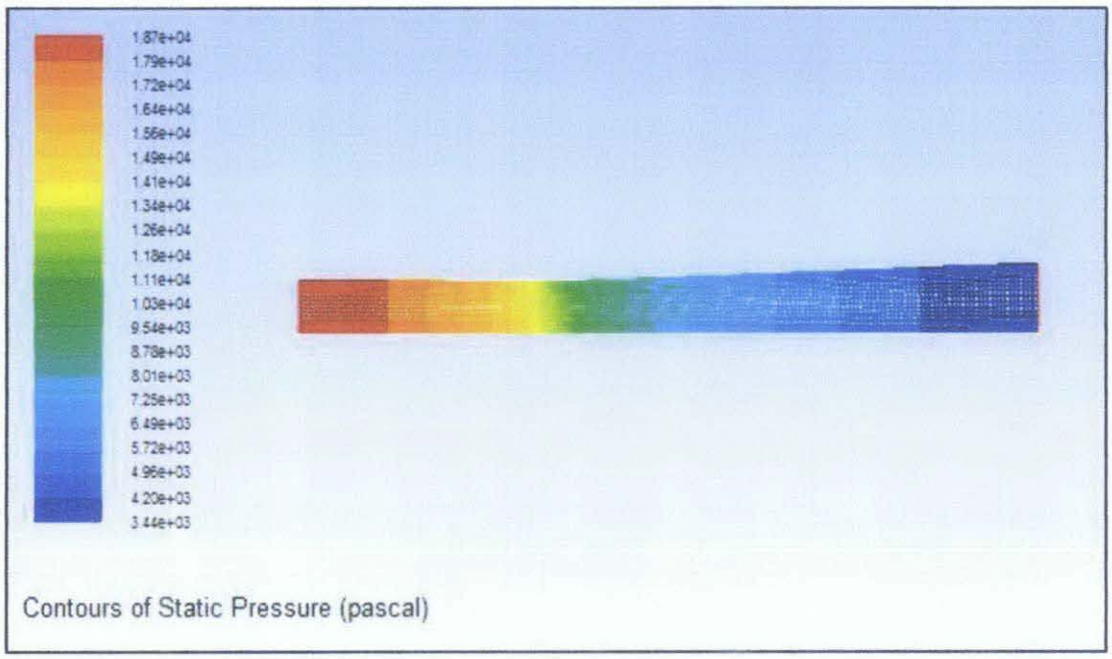
1. Static Pressure for Various Throat Diameter



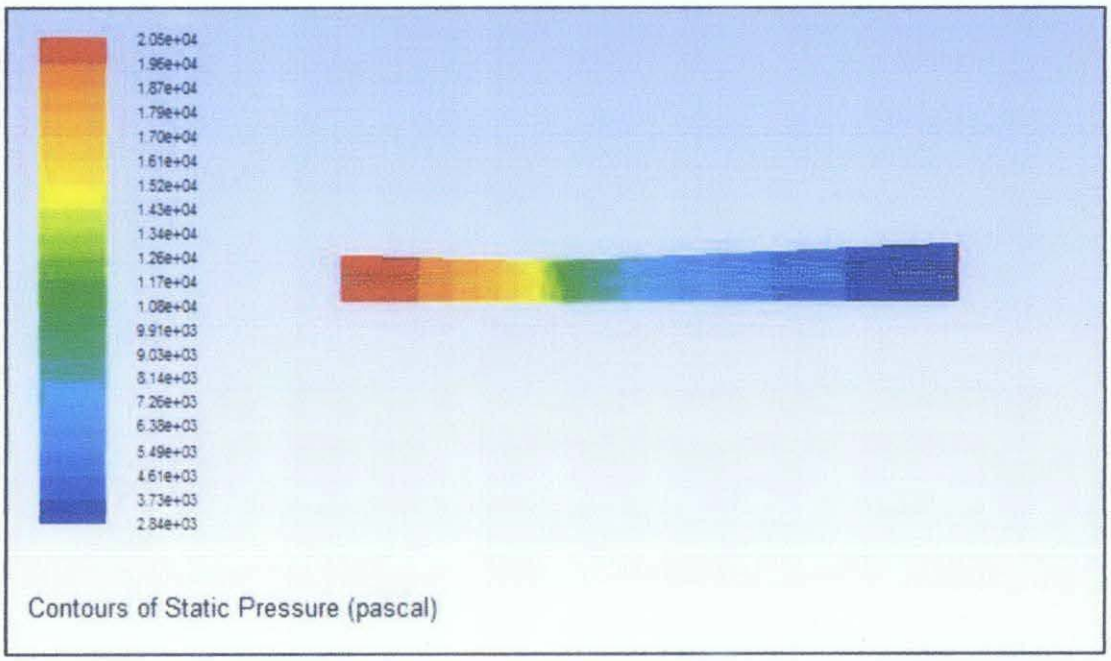
2. Contour Plot for Static Pressure (D_t = 0.05635 m)



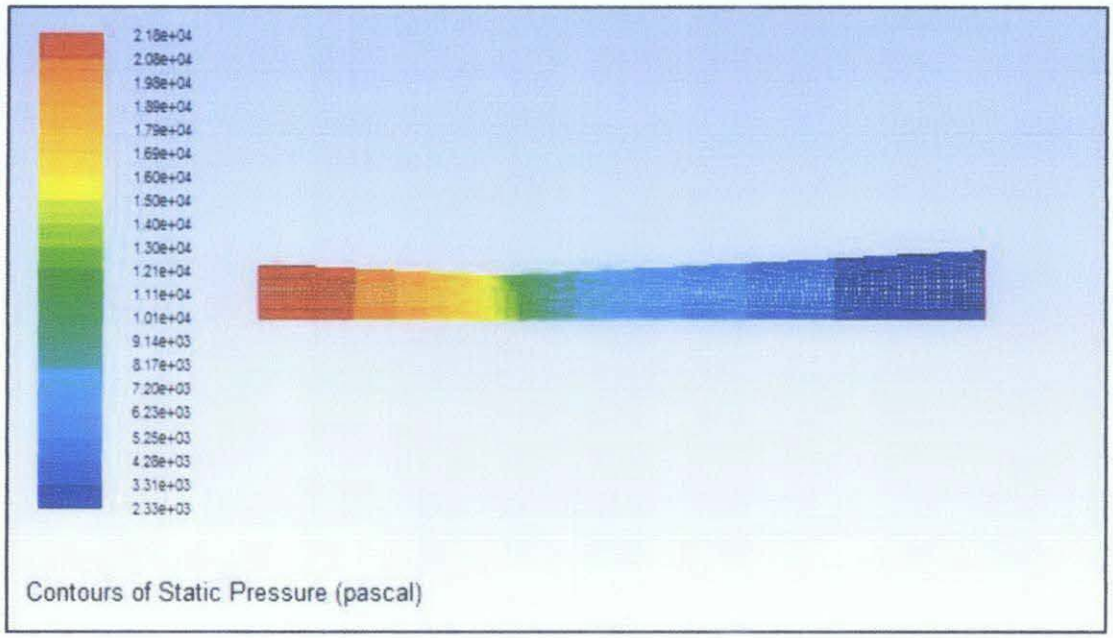
3. Contour Plot for Static Pressure (D_t = 0.053175 m)



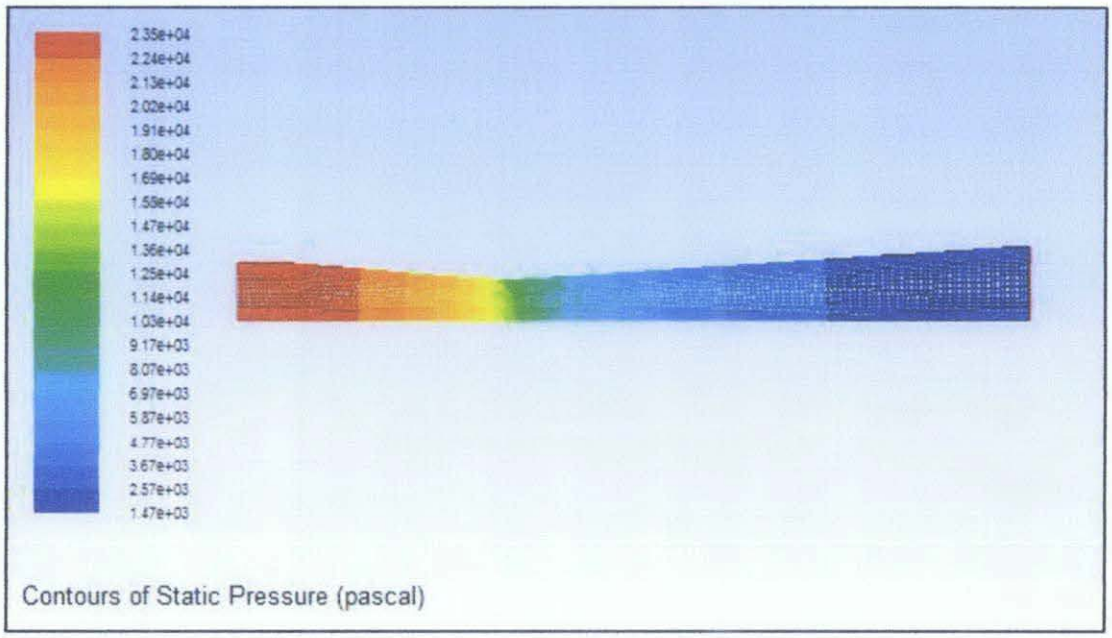
4. Contour Plot for Static Pressure (D_t = 0.05 m)



5. Contour Plot for Static Pressure (D_t = 0.046825 m)



6. Contour Plot for Static Pressure (D_t = 0.04 m)



Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
-0.25000	15743.50	18550.10	20361.40	21607.40	23287.10
-0.24776	15738.50	18549.90	20361.30	21607.30	23287.10
-0.24519	15724.20	18549.30	20361.00	21607.00	23286.80
-0.24071	15706.70	18547.30	20359.40	21605.50	23285.60
-0.23622	15685.20	18542.90	20355.50	21601.80	23282.60
-0.23173	15659.40	18535.90	20349.50	21596.20	23278.20
-0.22724	15628.60	18526.20	20341.00	21588.30	23272.20
-0.22276	15592.60	18513.80	20330.10	21578.20	23264.20
-0.21827	15551.60	18498.50	20316.40	21565.20	23254.00
-0.21378	15506.20	18480.50	20299.50	21549.00	23241.10
-0.20930	15457.10	18459.30	20278.90	21529.10	23225.10
-0.20481	15405.20	18434.60	20254.10	21504.80	23205.60
-0.20032	15351.40	18406.00	20224.50	21475.60	23182.00
-0.19583	15296.40	18373.10	20189.50	21441.00	23154.10
-0.19135	15240.90	18335.30	20148.70	21400.70	23121.60
-0.18686	15185.70	18292.60	20102.10	21354.60	23084.30
-0.18237	15131.30	18244.90	20049.80	21302.80	23042.40
-0.17789	15078.30	18192.70	19992.20	21245.80	22996.10
-0.17340	15026.70	18135.80	19929.30	21183.40	22944.90
-0.16891	14975.70	18073.90	19860.80	21115.20	22888.70
-0.16442	14924.40	18007.60	19787.40	21042.20	22828.20
-0.15994	14872.60	17937.70	19710.10	20965.10	22763.90
-0.15545	14820.10	17865.00	19629.60	20884.50	22695.90
-0.15096	14767.00	17790.10	19546.30	20800.60	22624.10
-0.14647	14713.10	17713.30	19460.20	20713.30	22548.60
-0.14199	14658.70	17634.80	19371.60	20622.80	22469.20
-0.13750	14603.70	17554.60	19280.40	20529.10	22385.90
-0.13301	14548.20	17472.60	19186.50	20432.10	22298.60
-0.12853	14492.00	17388.90	19089.90	20331.70	22207.10
-0.12404	14435.10	17303.20	18990.50	20227.80	22111.20
-0.11955	14377.50	17215.50	18888.20	20120.30	22010.60
-0.11506	14319.00	17125.60	18782.80	20008.80	21905.00
-0.11058	14259.60	17033.40	18674.10	19893.30	21794.10
-0.10609	14199.20	16938.80	18562.00	19773.50	21677.60
-0.10160	14137.60	16841.60	18446.30	19649.20	21555.10
-0.09712	14074.80	16741.60	18326.70	19520.00	21426.00
-0.09263	14010.60	16638.70	18203.00	19385.60	21290.00
-0.08814	13944.90	16532.60	18074.90	19245.70	21146.40
-0.08365	13877.50	16423.10	17942.10	19099.80	20994.70
-0.07917	13808.20	16309.90	17804.20	18947.60	20834.20
-0.07468	13736.90	16192.80	17660.80	18788.40	20663.90
-0.07019	13663.30	16071.40	17511.50	18621.80	20483.10

Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
-0.06571	13587.20	15945.40	17355.90	18447.10	20290.90
-0.06122	13508.30	15814.50	17193.40	18263.70	20086.00
-0.05673	13426.30	15678.10	17023.40	18070.70	19867.20
-0.05224	13341.00	15535.80	16845.30	17867.30	19633.10
-0.04776	13252.00	15387.10	16658.30	17652.50	19382.00
-0.04327	13158.90	15231.40	16461.70	17425.30	19112.10
-0.03878	13061.30	15068.10	16254.50	17184.40	18821.20
-0.03429	12958.70	14896.50	16035.70	16928.60	18507.10
-0.02981	12850.60	14715.80	15804.50	16656.40	18167.00
-0.02532	12736.50	14525.40	15559.60	16366.40	17798.30
-0.02083	12616.00	14324.50	15300.00	16057.00	17397.90
-0.01635	12488.50	14112.30	15024.70	15726.90	16963.00
-0.01186	12353.50	13888.20	14732.90	15374.90	16490.90
-0.00737	12210.50	13651.70	14423.70	14999.70	15979.30
-0.00288	12059.10	13402.10	14096.40	14600.60	15426.50
0.00160	11898.70	13138.90	13750.50	14176.90	14831.40
0.00609	11728.50	12861.10	13384.90	13727.70	14193.90
0.01058	11546.10	12565.60	12995.90	13248.80	13510.50
0.01506	11349.90	12251.50	12584.60	12744.40	12796.50
0.01955	11141.30	11924.20	12160.60	12229.10	12082.20
0.02404	10924.00	11590.90	11734.30	11716.50	11389.30
0.02853	10702.00	11258.80	11315.50	11219.10	10734.90
0.03301	10479.60	10934.50	10912.70	10746.80	10131.70
0.03750	10260.90	10623.90	10532.90	10307.50	9587.92
0.04199	10049.70	10331.80	10181.50	9906.92	9107.52
0.04647	9849.11	10061.70	9862.09	9548.01	8690.43
0.05096	9661.74	9815.89	9576.21	9231.41	8333.06
0.05545	9489.11	9594.98	9323.51	8955.41	8029.14
0.05994	9331.79	9398.21	9101.90	8716.29	7770.52
0.06442	9189.41	9223.62	8907.86	8508.94	7548.19
0.06891	9060.80	9068.26	8736.94	8327.39	7353.16
0.07340	8944.15	8928.68	8584.26	8165.50	7177.28
0.07788	8837.32	8801.22	8445.03	8017.50	7013.77
0.08237	8738.02	8682.42	8314.90	7878.47	6857.44
0.08686	8644.08	8569.28	8190.32	7744.53	6704.78
0.09135	8553.59	8459.39	8068.60	7612.95	6553.71
0.09583	8465.04	8351.01	7947.94	7482.05	6403.32
0.10032	8377.31	8243.05	7827.35	7351.02	6253.49
0.10481	8289.68	8134.95	7706.45	7219.74	6104.65
0.10930	8201.81	8026.59	7585.34	7088.50	5957.48
0.11378	8113.62	7918.15	7464.37	6957.86	5812.74
0.11827	8025.22	7809.98	7344.09	6828.46	5671.13

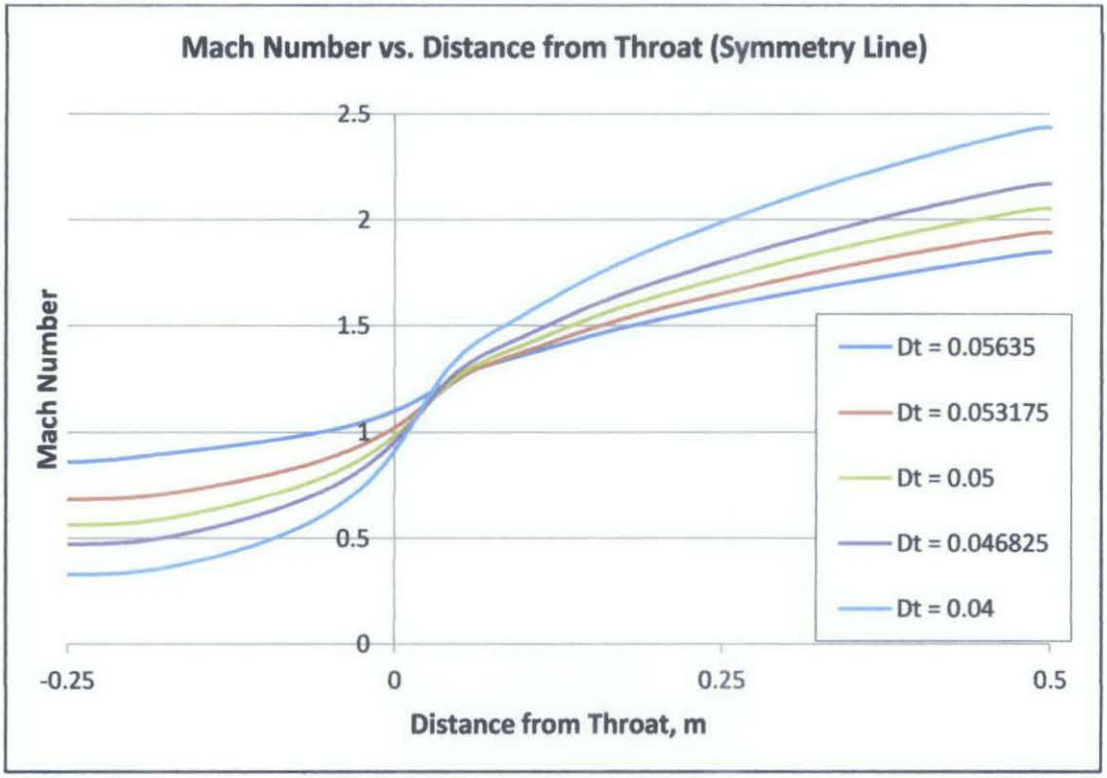
Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
0.12276	7936.88	7702.53	7225.07	6700.96	5533.28
0.12724	7848.90	7596.25	7107.83	6575.94	5399.65
0.13173	7761.63	7491.57	6992.88	6453.88	5270.60
0.13622	7675.38	7388.86	6880.59	6335.16	5146.32
0.14071	7590.45	7288.42	6771.25	6220.04	5026.91
0.14519	7507.05	7190.46	6665.08	6108.68	4912.36
0.14968	7425.38	7095.15	6562.19	6001.16	4802.60
0.15417	7345.58	7002.55	6462.63	5897.47	4697.48
0.15865	7267.72	6912.70	6366.37	5797.54	4596.81
0.16314	7191.84	6825.58	6273.36	5701.28	4500.38
0.16763	7117.96	6741.12	6183.49	5608.53	4407.95
0.17212	7046.03	6659.23	6096.61	5519.11	4319.27
0.17660	6976.00	6579.80	6012.58	5432.83	4234.07
0.18109	6907.79	6502.68	5931.22	5349.49	4152.10
0.18558	6841.32	6427.73	5852.35	5268.88	4073.13
0.19006	6776.48	6354.81	5775.77	5190.78	3996.90
0.19455	6713.17	6283.75	5701.33	5114.99	3923.20
0.19904	6651.26	6214.42	5628.83	5041.33	3851.83
0.20353	6590.66	6146.66	5558.11	4969.62	3782.59
0.20801	6531.25	6080.34	5489.03	4899.68	3715.33
0.21250	6472.94	6015.36	5421.44	4831.38	3649.88
0.21699	6415.63	5951.58	5355.22	4764.58	3586.13
0.22147	6359.25	5888.94	5290.28	4699.17	3523.95
0.22596	6303.72	5827.33	5226.51	4635.05	3463.26
0.23045	6248.98	5766.70	5163.85	4572.15	3403.97
0.23494	6194.99	5706.99	5102.23	4510.40	3346.02
0.23942	6141.70	5648.17	5041.61	4449.76	3289.35
0.24391	6089.08	5590.20	4981.96	4390.18	3233.92
0.24840	6037.11	5533.06	4923.26	4331.64	3179.70
0.25289	5985.79	5476.73	4865.48	4274.11	3126.65
0.25737	5935.09	5421.22	4808.61	4217.60	3074.75
0.26186	5885.02	5366.51	4752.67	4162.07	3023.98
0.26635	5835.59	5312.62	4697.63	4107.54	2974.33
0.27083	5786.78	5259.54	4643.50	4054.00	2925.77
0.27532	5738.61	5207.27	4590.29	4001.45	2878.31
0.27981	5691.08	5155.83	4538.00	3949.89	2831.92
0.28430	5644.20	5105.20	4486.62	3899.30	2786.58
0.28878	5597.98	5055.40	4436.16	3849.70	2742.30
0.29327	5552.40	5006.42	4386.61	3801.07	2699.04
0.29776	5507.48	4958.26	4337.97	3753.41	2656.79
0.30224	5463.20	4910.91	4290.23	3706.70	2615.54
0.30673	5419.58	4864.36	4243.37	3660.93	2575.26

Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
0.31122	5376.59	4818.60	4197.38	3616.10	2535.93
0.31571	5334.23	4773.62	4152.26	3572.17	2497.54
0.32019	5292.50	4729.41	4107.98	3529.13	2460.06
0.32468	5251.37	4685.93	4064.52	3486.96	2423.46
0.32917	5210.84	4643.18	4021.86	3445.65	2387.73
0.33365	5170.88	4601.14	3979.99	3405.16	2352.83
0.33814	5131.48	4559.79	3938.87	3365.47	2318.74
0.34263	5092.63	4519.10	3898.48	3326.56	2285.44
0.34712	5054.30	4479.05	3858.81	3288.40	2252.91
0.35160	5016.49	4439.63	3819.82	3250.97	2221.10
0.35609	4979.17	4400.82	3781.50	3214.24	2190.01
0.36058	4942.32	4362.58	3743.82	3178.20	2159.61
0.36506	4905.94	4324.91	3706.76	3142.81	2129.88
0.36955	4870.00	4287.79	3670.31	3108.05	2100.78
0.37404	4834.50	4251.19	3634.43	3073.91	2072.30
0.37853	4799.41	4215.11	3599.11	3040.36	2044.42
0.38301	4764.73	4179.53	3564.34	3007.38	2017.12
0.38750	4730.44	4144.43	3530.10	2974.96	1990.37
0.39199	4696.54	4109.80	3496.36	2943.07	1964.17
0.39647	4663.02	4075.64	3463.13	2911.70	1938.48
0.40096	4629.86	4041.93	3430.38	2880.83	1913.30
0.40545	4597.06	4008.65	3398.10	2850.46	1888.61
0.40994	4564.61	3975.82	3366.29	2820.57	1864.39
0.41442	4532.52	3943.41	3334.93	2791.14	1840.63
0.41891	4500.76	3911.41	3304.01	2762.17	1817.32
0.42340	4469.34	3879.84	3273.53	2733.65	1794.43
0.42789	4438.26	3848.67	3243.49	2705.57	1771.98
0.43237	4407.50	3817.91	3213.86	2677.91	1749.93
0.43686	4377.08	3787.55	3184.65	2650.68	1728.28
0.44135	4346.97	3757.58	3155.86	2623.86	1707.02
0.44583	4317.18	3728.01	3127.47	2597.45	1686.14
0.45032	4287.72	3698.83	3099.49	2571.44	1665.64
0.45481	4258.57	3670.04	3071.91	2545.83	1645.50
0.45930	4229.73	3641.65	3044.72	2520.61	1625.72
0.46378	4201.23	3613.64	3017.94	2495.79	1606.29
0.46827	4173.08	3586.06	2991.57	2471.36	1587.21
0.47276	4145.32	3558.93	2965.65	2447.37	1568.50
0.47724	4118.09	3532.39	2940.26	2423.86	1550.19
0.48173	4091.63	3506.69	2915.62	2401.02	1532.40
0.48622	4066.50	3482.43	2892.26	2379.29	1515.40
0.49071	4043.92	3460.96	2871.36	2359.73	1499.91
0.49519	4027.31	3446.21	2856.76	2345.92	1488.74

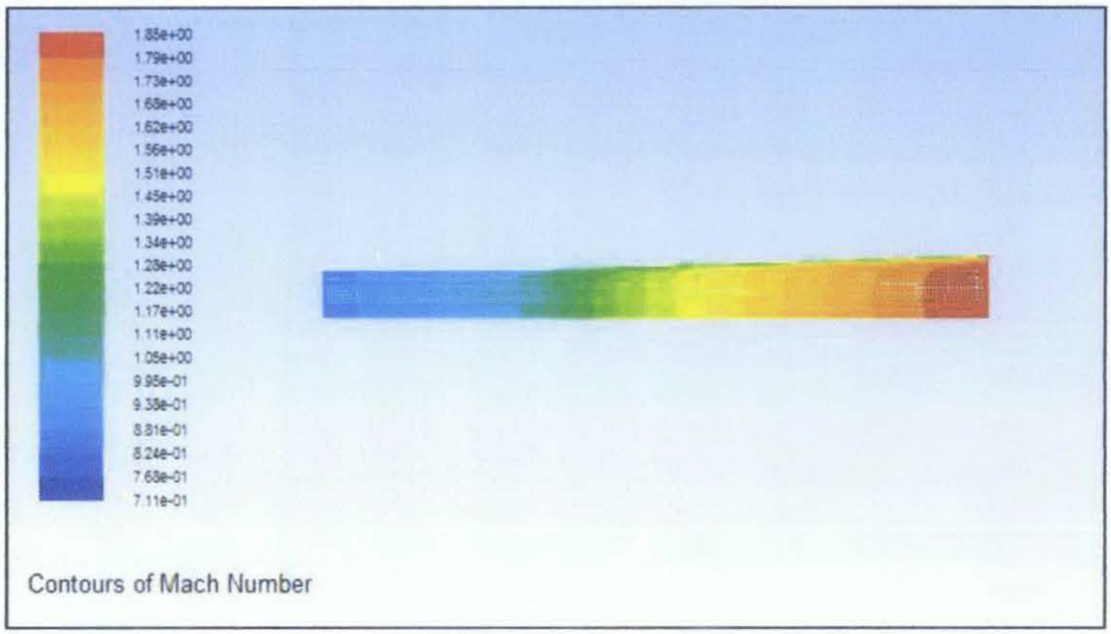
Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
0.49776	4017.15	3439.41	2849.62	2338.95	1482.58
0.50000	4013.14	3437.56	2847.47	2336.73	1480.34

APPENDIX VII: MANIPULATED VARIABLE – THROAT DIAMETER (MACH NUMBER)

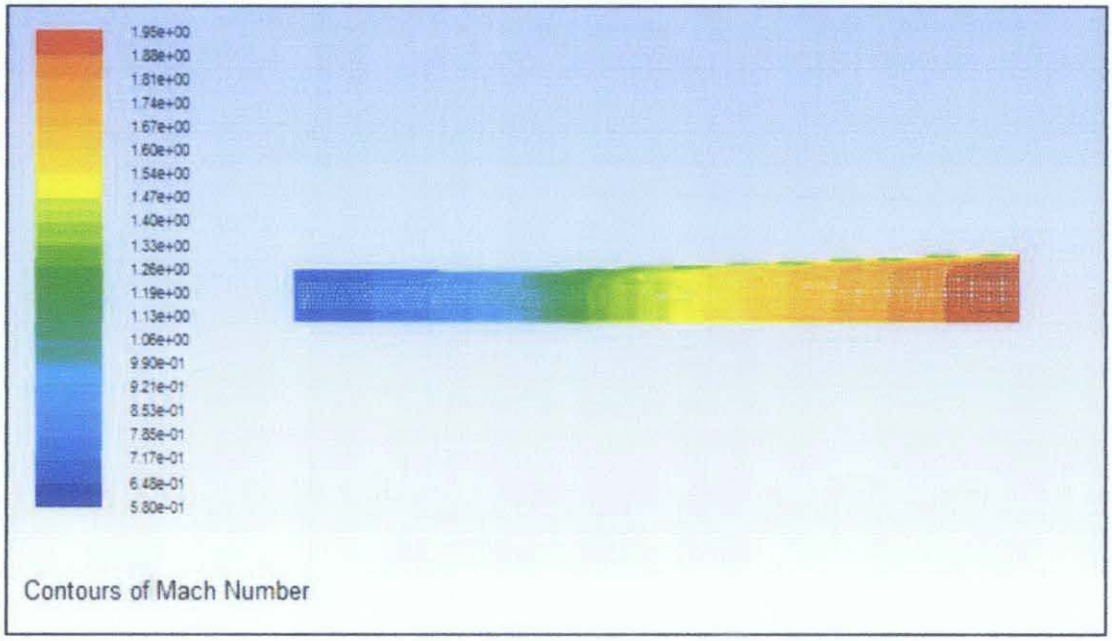
1. Mach Number for Various Throat Diameter



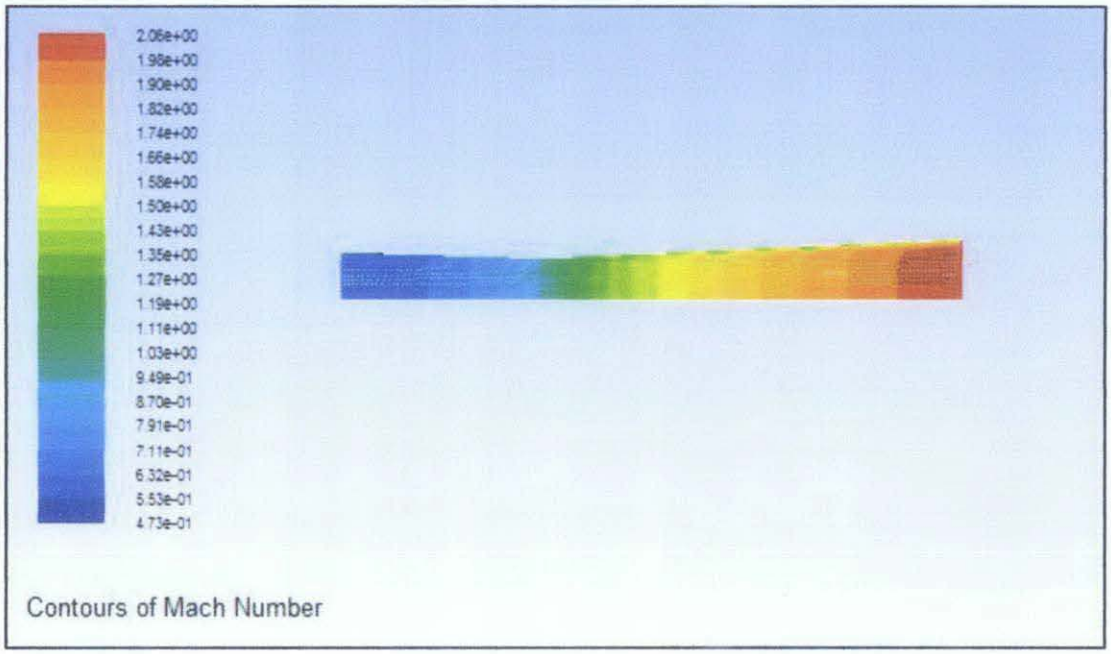
2. Contour Plot for Mach Number (D_t = 0.05635 m)



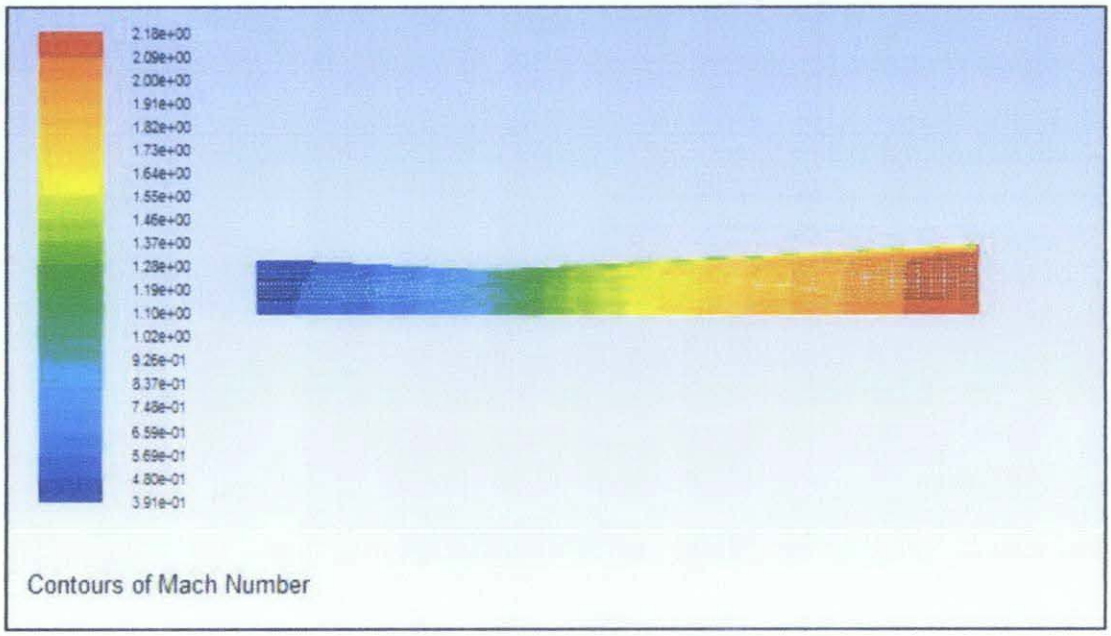
3. Contour Plot for Mach Number (D_t = 0.053175 m)



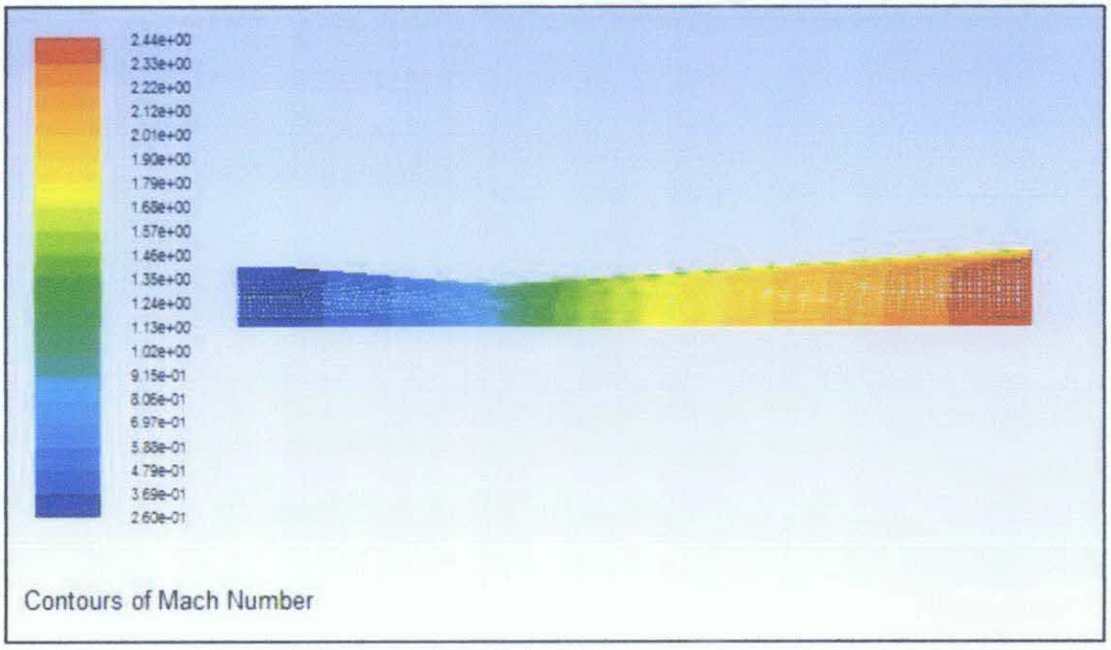
4. Contour Plot for Mach Number (D_t = 0.05 m)



5. Contour Plot for Mach Number (D_t = 0.046825 m)



6. Contour Plot for Mach Number (D_t = 0.04 m)



Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
-0.25000	0.85958	0.68323	0.56353	0.47341	0.32883
-0.24776	0.85973	0.68324	0.56354	0.47342	0.32884
-0.24519	0.86019	0.68330	0.56360	0.47348	0.32891
-0.24071	0.86117	0.68352	0.56381	0.47370	0.32914
-0.23622	0.86231	0.68388	0.56415	0.47406	0.32951
-0.23173	0.86377	0.68441	0.56466	0.47457	0.33004
-0.22724	0.86557	0.68512	0.56533	0.47526	0.33074
-0.22276	0.86771	0.68600	0.56618	0.47614	0.33165
-0.21827	0.87016	0.68706	0.56723	0.47725	0.33280
-0.21378	0.87286	0.68831	0.56852	0.47862	0.33423
-0.20930	0.87578	0.68977	0.57008	0.48029	0.33598
-0.20481	0.87886	0.69146	0.57195	0.48231	0.33809
-0.20032	0.88204	0.69341	0.57416	0.48471	0.34060
-0.19583	0.88528	0.69565	0.57674	0.48751	0.34352
-0.19135	0.88853	0.69820	0.57970	0.49073	0.34687
-0.18686	0.89176	0.70105	0.58305	0.49436	0.35063
-0.18237	0.89493	0.70421	0.58676	0.49837	0.35478
-0.17789	0.89802	0.70765	0.59081	0.50275	0.35932
-0.17340	0.90107	0.71140	0.59523	0.50752	0.36428
-0.16891	0.90412	0.71543	0.59997	0.51264	0.36959
-0.16442	0.90720	0.71971	0.60498	0.51804	0.37520
-0.15994	0.91033	0.72418	0.61020	0.52368	0.38108
-0.15545	0.91351	0.72880	0.61561	0.52952	0.38721
-0.15096	0.91674	0.73353	0.62117	0.53557	0.39360
-0.14647	0.92002	0.73838	0.62689	0.54180	0.40023
-0.14199	0.92335	0.74332	0.63275	0.54822	0.40711
-0.13750	0.92671	0.74837	0.63877	0.55482	0.41422
-0.13301	0.93013	0.75352	0.64494	0.56162	0.42159
-0.12853	0.93359	0.75878	0.65126	0.56860	0.42921
-0.12404	0.93711	0.76417	0.65775	0.57579	0.43711
-0.11955	0.94068	0.76967	0.66441	0.58319	0.44528
-0.11506	0.94432	0.77532	0.67124	0.59080	0.45375
-0.11058	0.94804	0.78110	0.67827	0.59865	0.46253
-0.10609	0.95183	0.78704	0.68550	0.60675	0.47164
-0.10160	0.95570	0.79314	0.69295	0.61511	0.48111
-0.09712	0.95967	0.79941	0.70062	0.62375	0.49096
-0.09263	0.96375	0.80587	0.70854	0.63269	0.50121
-0.08814	0.96793	0.81254	0.71673	0.64195	0.51190
-0.08365	0.97224	0.81942	0.72520	0.65155	0.52306
-0.07917	0.97669	0.82653	0.73397	0.66154	0.53474
-0.07468	0.98129	0.83390	0.74308	0.67192	0.54697
-0.07019	0.98605	0.84154	0.75255	0.68275	0.55980

Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
-0.06571	0.99100	0.84949	0.76241	0.69405	0.57330
-0.06122	0.99615	0.85776	0.77270	0.70588	0.58752
-0.05673	1.00152	0.86638	0.78345	0.71828	0.60255
-0.05224	1.00714	0.87540	0.79472	0.73130	0.61845
-0.04776	1.01303	0.88484	0.80654	0.74502	0.63534
-0.04327	1.01923	0.89475	0.81897	0.75949	0.65332
-0.03878	1.02575	0.90517	0.83208	0.77480	0.67252
-0.03429	1.03265	0.91616	0.84593	0.79104	0.69307
-0.02981	1.03994	0.92775	0.86060	0.80829	0.71513
-0.02532	1.04768	0.94002	0.87615	0.82666	0.73888
-0.02083	1.05592	0.95302	0.89266	0.84625	0.76450
-0.01635	1.06471	0.96679	0.91022	0.86716	0.79216
-0.01186	1.07406	0.98140	0.92889	0.88949	0.82206
-0.00737	1.08402	0.99690	0.94875	0.91334	0.85436
-0.00288	1.09464	1.01334	0.96987	0.93880	0.88924
0.00160	1.10596	1.03081	0.99234	0.96598	0.92687
0.00609	1.11813	1.04949	1.01639	0.99516	0.96764
0.01058	1.13129	1.06959	1.04218	1.02647	1.01147
0.01506	1.14544	1.09094	1.06946	1.05944	1.05725
0.01955	1.16049	1.11325	1.09778	1.09344	1.10380
0.02404	1.17615	1.13601	1.12637	1.12752	1.14965
0.02853	1.19214	1.15876	1.15466	1.16095	1.19379
0.03301	1.20819	1.18111	1.18213	1.19311	1.23541
0.03750	1.22401	1.20266	1.20831	1.22348	1.27387
0.04199	1.23934	1.22309	1.23281	1.25161	1.30873
0.04647	1.25393	1.24213	1.25537	1.27724	1.33982
0.05096	1.26763	1.25963	1.27583	1.30024	1.36720
0.05545	1.28033	1.27553	1.29419	1.32068	1.39118
0.05994	1.29198	1.28987	1.31056	1.33876	1.41226
0.06442	1.30263	1.30279	1.32518	1.35483	1.43105
0.06891	1.31236	1.31449	1.33836	1.36929	1.44821
0.07340	1.32133	1.32523	1.35043	1.38258	1.46430
0.07788	1.32968	1.33527	1.36175	1.39511	1.47985
0.08237	1.33759	1.34484	1.37261	1.40724	1.49521
0.08686	1.34522	1.35416	1.38326	1.41922	1.51063
0.09135	1.35269	1.36339	1.39388	1.43125	1.52623
0.09583	1.36012	1.37263	1.40458	1.44342	1.54207
0.10032	1.36758	1.38195	1.41542	1.45578	1.55812
0.10481	1.37510	1.39139	1.42641	1.46832	1.57433
0.10930	1.38271	1.40092	1.43753	1.48099	1.59062
0.11378	1.39041	1.41055	1.44874	1.49375	1.60690
0.11827	1.39816	1.42022	1.45999	1.50654	1.62310

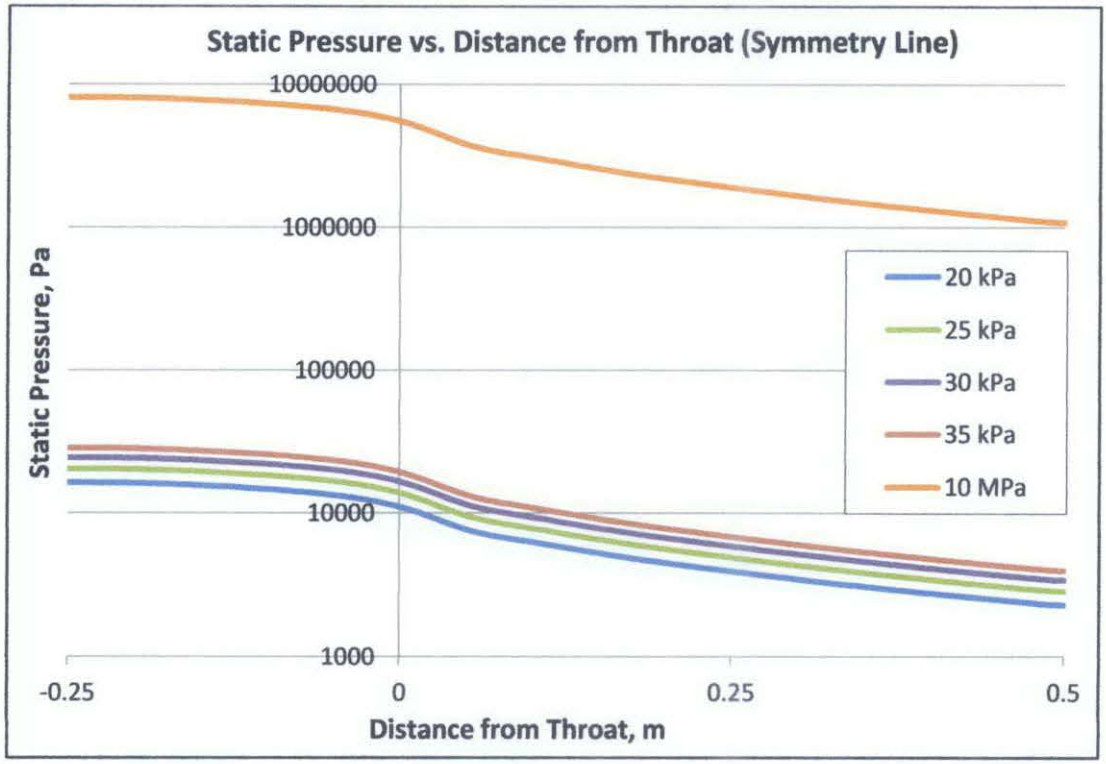
Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
0.12276	1.40596	1.42990	1.47123	1.51929	1.63915
0.12724	1.41377	1.43956	1.48242	1.53194	1.65499
0.13173	1.42157	1.44914	1.49350	1.54445	1.67058
0.13622	1.42932	1.45863	1.50444	1.55678	1.68587
0.14071	1.43700	1.46798	1.51521	1.56890	1.70084
0.14519	1.44459	1.47719	1.52579	1.58078	1.71549
0.14968	1.45207	1.48624	1.53616	1.59242	1.72980
0.15417	1.45944	1.49511	1.54632	1.60380	1.74377
0.15865	1.46668	1.50381	1.55625	1.61492	1.75740
0.16314	1.47379	1.51232	1.56597	1.62579	1.77072
0.16763	1.48077	1.52066	1.57548	1.63642	1.78374
0.17212	1.48761	1.52882	1.58478	1.64681	1.79647
0.17660	1.49433	1.53683	1.59389	1.65698	1.80894
0.18109	1.50093	1.54467	1.60281	1.66694	1.82116
0.18558	1.50741	1.55238	1.61157	1.67671	1.83315
0.19006	1.51378	1.55995	1.62017	1.68631	1.84495
0.19455	1.52005	1.56741	1.62864	1.69576	1.85656
0.19904	1.52623	1.57475	1.63699	1.70507	1.86802
0.20353	1.53233	1.58200	1.64522	1.71425	1.87933
0.20801	1.53836	1.58917	1.65336	1.72333	1.89052
0.21250	1.54433	1.59626	1.66141	1.73232	1.90159
0.21699	1.55023	1.60328	1.66939	1.74122	1.91257
0.22147	1.55609	1.61025	1.67730	1.75005	1.92346
0.22596	1.56190	1.61716	1.68515	1.75881	1.93427
0.23045	1.56768	1.62402	1.69296	1.76752	1.94501
0.23494	1.57341	1.63084	1.70071	1.77617	1.95567
0.23942	1.57912	1.63762	1.70841	1.78477	1.96627
0.24391	1.58479	1.64435	1.71608	1.79332	1.97681
0.24840	1.59043	1.65105	1.72369	1.80183	1.98728
0.25289	1.59604	1.65771	1.73127	1.81028	1.99769
0.25737	1.60162	1.66432	1.73879	1.81869	2.00804
0.26186	1.60717	1.67089	1.74628	1.82704	2.01831
0.26635	1.61268	1.67742	1.75371	1.83534	2.02852
0.27083	1.61816	1.68391	1.76109	1.84358	2.03866
0.27532	1.62361	1.69034	1.76841	1.85176	2.04872
0.27981	1.62902	1.69672	1.77568	1.85988	2.05870
0.28430	1.63439	1.70306	1.78290	1.86794	2.06860
0.28878	1.63972	1.70934	1.79005	1.87592	2.07842
0.29327	1.64502	1.71556	1.79714	1.88384	2.08816
0.29776	1.65027	1.72173	1.80416	1.89169	2.09781
0.30224	1.65548	1.72784	1.81113	1.89947	2.10737
0.30673	1.66065	1.73389	1.81802	1.90718	2.11684

Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
0.31122	1.66577	1.73989	1.82486	1.91481	2.12622
0.31571	1.67086	1.74583	1.83162	1.92236	2.13552
0.32019	1.67590	1.75172	1.83832	1.92985	2.14472
0.32468	1.68091	1.75755	1.84496	1.93726	2.15383
0.32917	1.68587	1.76332	1.85154	1.94460	2.16285
0.33365	1.69080	1.76905	1.85805	1.95187	2.17179
0.33814	1.69569	1.77472	1.86450	1.95907	2.18063
0.34263	1.70055	1.78033	1.87090	1.96621	2.18939
0.34712	1.70537	1.78590	1.87723	1.97327	2.19807
0.35160	1.71016	1.79143	1.88351	1.98028	2.20666
0.35609	1.71492	1.79690	1.88974	1.98722	2.21517
0.36058	1.71965	1.80233	1.89591	1.99409	2.22359
0.36506	1.72436	1.80772	1.90203	2.00091	2.23194
0.36955	1.72903	1.81306	1.90810	2.00768	2.24022
0.37404	1.73368	1.81836	1.91413	2.01438	2.24841
0.37853	1.73831	1.82362	1.92011	2.02104	2.25653
0.38301	1.74291	1.82885	1.92604	2.02764	2.26458
0.38750	1.74749	1.83403	1.93193	2.03419	2.27256
0.39199	1.75205	1.83917	1.93777	2.04069	2.28046
0.39647	1.75659	1.84428	1.94357	2.04713	2.28830
0.40096	1.76111	1.84934	1.94932	2.05353	2.29606
0.40545	1.76561	1.85437	1.95504	2.05989	2.30376
0.40994	1.77009	1.85936	1.96071	2.06619	2.31140
0.41442	1.77455	1.86432	1.96634	2.07244	2.31896
0.41891	1.77900	1.86923	1.97192	2.07865	2.32646
0.42340	1.78342	1.87410	1.97746	2.08481	2.33389
0.42789	1.78783	1.87894	1.98296	2.09092	2.34126
0.43237	1.79222	1.88373	1.98842	2.09698	2.34856
0.43686	1.79659	1.88849	1.99382	2.10299	2.35580
0.44135	1.80094	1.89320	1.99919	2.10895	2.36296
0.44583	1.80527	1.89787	2.00450	2.11486	2.37006
0.45032	1.80959	1.90249	2.00977	2.12071	2.37710
0.45481	1.81389	1.90707	2.01499	2.12651	2.38406
0.45930	1.81816	1.91161	2.02015	2.13225	2.39095
0.46378	1.82242	1.91609	2.02526	2.13794	2.39777
0.46827	1.82664	1.92051	2.03031	2.14355	2.40451
0.47276	1.83082	1.92485	2.03528	2.14908	2.41116
0.47724	1.83492	1.92908	2.04013	2.15449	2.41766
0.48173	1.83888	1.93311	2.04478	2.15969	2.42393
0.48622	1.84254	1.93673	2.04900	2.16444	2.42970
0.49071	1.84558	1.93950	2.05228	2.16818	2.43431
0.49519	1.84782	1.94095	2.05413	2.17032	2.43711

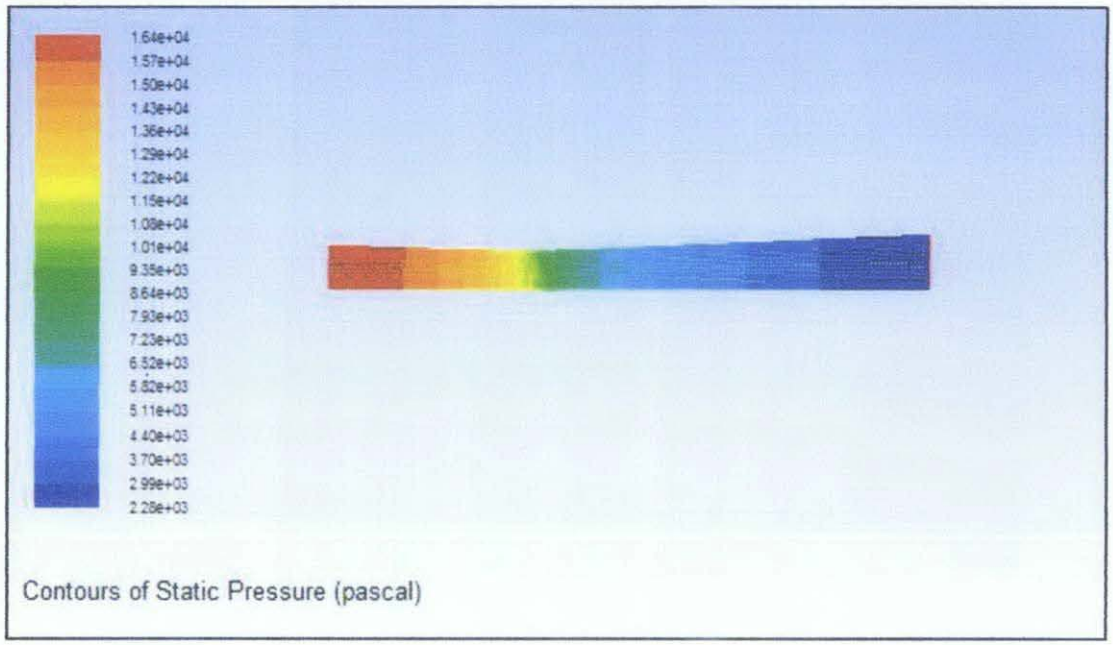
Diameter	0.05635	0.053175	0.05	0.046825	0.04
x	y	y	y	y	y
0.49776	1.84868	1.94068	2.05398	2.17025	2.43736
0.50000	1.84898	1.94025	2.05358	2.16986	2.43712

APPENDIX VIII: MANIPULATED VARIABLE – INLET PRESSURE (STATIC PRESSURE)

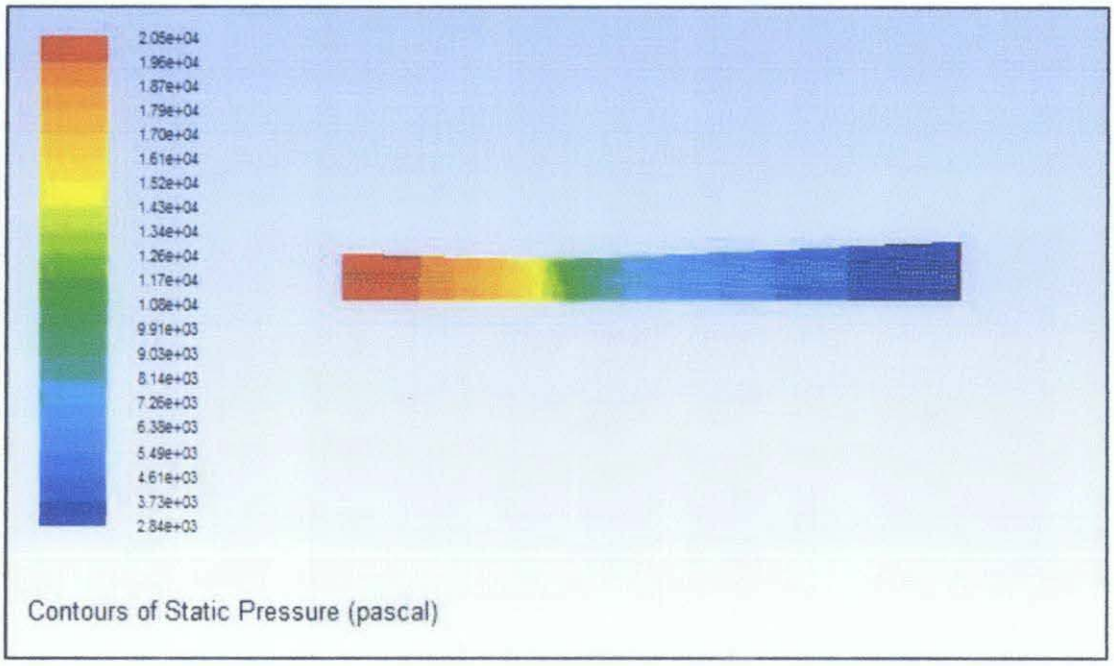
1. Static Pressure for Various Inlet Pressure



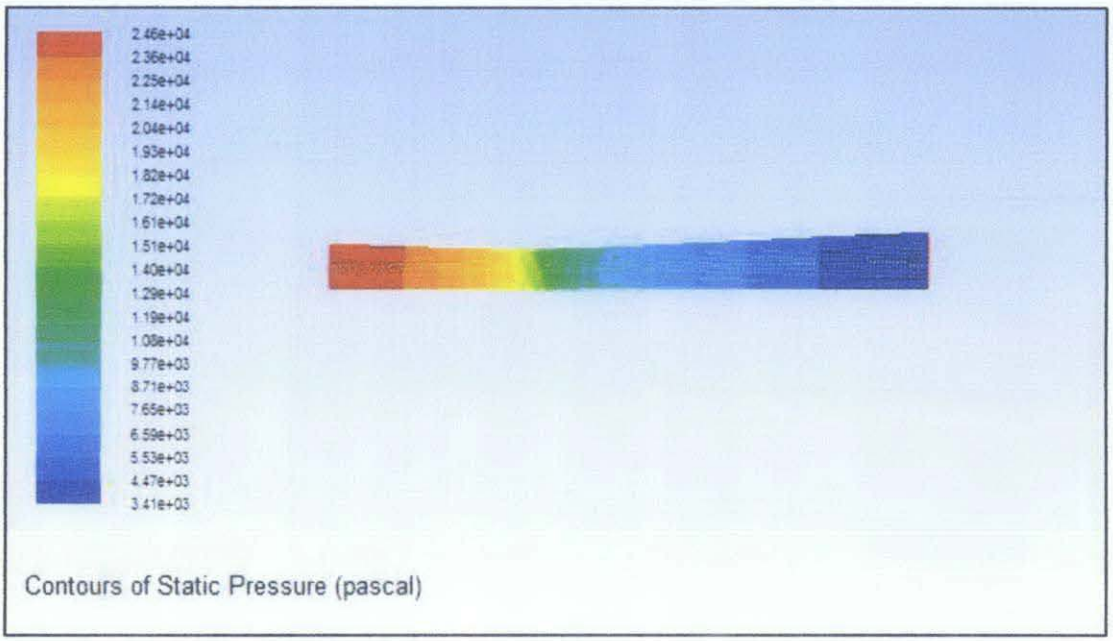
2. Contour Plot for Static Pressure (P_{inlet} = 20 kPa)



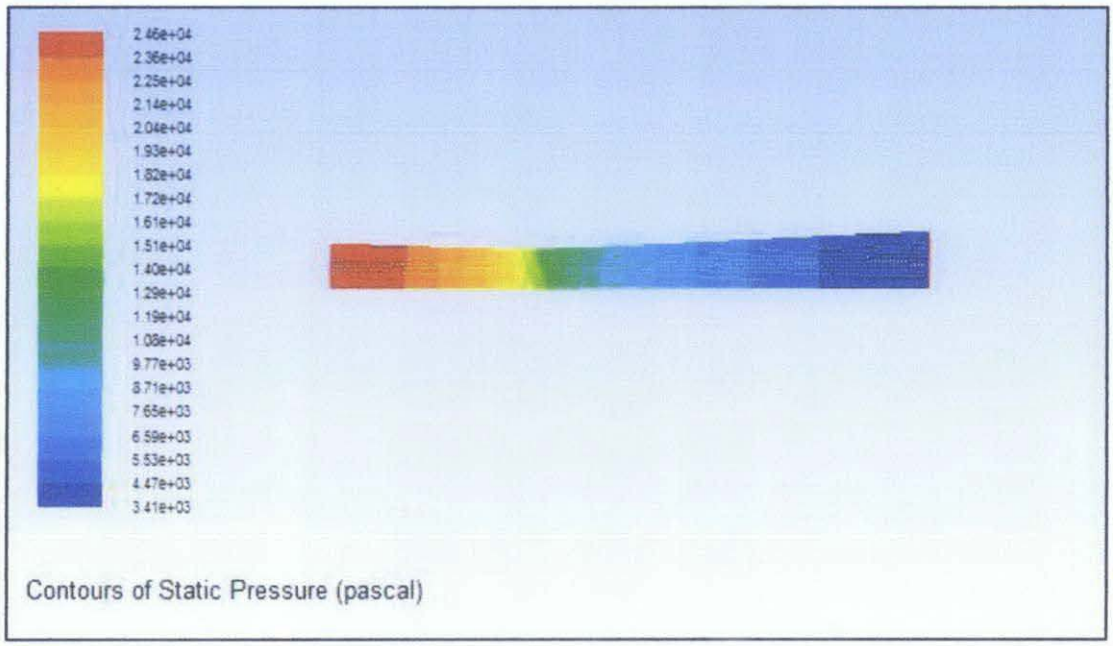
3. Contour Plot for Static Pressure (P_{inlet} = 25 kPa)



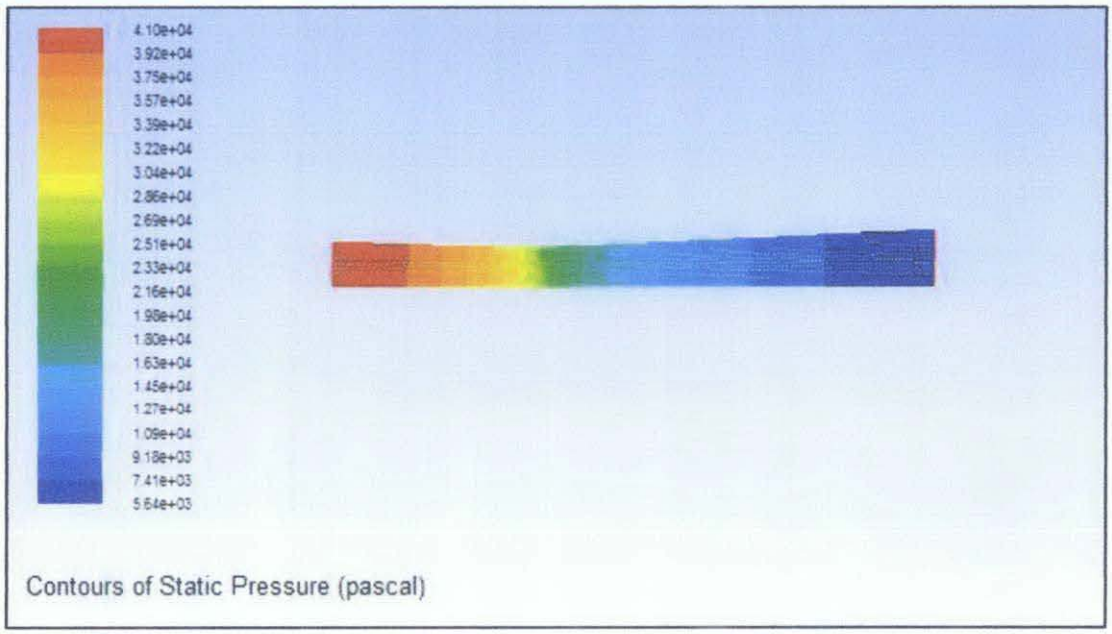
4. Contour Plot for Static Pressure (P_{inlet} = 30 kPa)



5. Contour Plot for Static Pressure (P_{inlet} = 35 kPa)



6. Contour Plot for Static Pressure (P_{inlet} = 50 MPa)



Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
-0.25000	16294.40	20361.40	24427.60	28493.20	8110530
-0.24776	16294.30	20361.30	24427.50	28493.00	8110510
-0.24519	16294.00	20361.00	24427.10	28492.60	8110410
-0.24071	16292.70	20359.40	24425.30	28490.50	8109960
-0.23622	16289.60	20355.50	24420.70	28485.30	8108910
-0.23173	16284.50	20349.50	24413.60	28477.10	8107200
-0.22724	16277.60	20341.00	24403.70	28465.70	8104780
-0.22276	16268.70	20330.10	24390.80	28450.90	8101520
-0.21827	16257.50	20316.40	24374.60	28432.30	8097270
-0.21378	16243.70	20299.50	24354.60	28409.20	8091830
-0.20930	16227.00	20278.90	24330.20	28381.00	8084940
-0.20481	16206.90	20254.10	24300.70	28346.90	8076340
-0.20032	16183.00	20224.50	24265.40	28305.90	8065780
-0.19583	16154.70	20189.50	24223.70	28257.50	8053010
-0.19135	16121.90	20148.70	24175.10	28201.00	8037870
-0.18686	16084.40	20102.10	24119.40	28136.20	8020300
-0.18237	16042.40	20049.80	24056.80	28063.40	8000350
-0.17789	15996.20	19992.20	23987.90	27983.20	7978240
-0.17340	15945.70	19929.30	23912.60	27895.50	7953950
-0.16891	15890.70	19860.80	23830.50	27799.90	7927400
-0.16442	15831.90	19787.40	23742.60	27697.50	7898880
-0.15994	15769.90	19710.10	23650.00	27589.60	7868780
-0.15545	15705.40	19629.60	23553.60	27477.30	7837410
-0.15096	15638.60	19546.30	23453.70	27360.90	7804920
-0.14647	15569.60	19460.20	23350.60	27240.80	7771380
-0.14199	15498.60	19371.60	23244.40	27117.00	7736800
-0.13750	15425.50	19280.40	23135.00	26989.50	7701200
-0.13301	15350.30	19186.50	23022.50	26858.40	7664540
-0.12853	15272.90	19089.90	22906.80	26723.50	7626790
-0.12404	15193.30	18990.50	22787.60	26584.60	7587920
-0.11955	15111.30	18888.20	22665.00	26441.60	7547880
-0.11506	15026.90	18782.80	22538.60	26294.30	7506600
-0.11058	14939.80	18674.10	22408.30	26142.50	7464030
-0.10609	14850.00	18562.00	22273.90	25985.80	7420080
-0.10160	14757.30	18446.30	22135.20	25824.10	7374690
-0.09712	14661.50	18326.70	21991.80	25656.90	7327750
-0.09263	14562.40	18203.00	21843.50	25484.00	7279160
-0.08814	14459.80	18074.90	21689.90	25304.90	7228820
-0.08365	14353.50	17942.10	21530.70	25119.30	7176590
-0.07917	14243.00	17804.20	21365.30	24926.50	7122330
-0.07468	14128.20	17660.80	21193.40	24726.10	7065890

Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
-0.07019	14008.70	17511.50	21014.50	24517.40	7007080
-0.06571	13884.10	17355.90	20827.80	24299.80	6945730
-0.06122	13754.00	17193.40	20633.00	24072.60	6881610
-0.05673	13617.90	17023.40	20429.10	23834.90	6814490
-0.05224	13475.30	16845.30	20215.50	23585.80	6744090
-0.04776	13325.60	16658.30	19991.30	23324.30	6670130
-0.04327	13168.10	16461.70	19755.40	23049.20	6592250
-0.03878	13002.30	16254.50	19506.80	22759.40	6510110
-0.03429	12827.20	16035.70	19244.50	22453.30	6423300
-0.02981	12642.10	15804.50	18967.00	22129.70	6331380
-0.02532	12446.10	15559.60	18673.20	21787.00	6233910
-0.02083	12238.50	15300.00	18361.80	21423.70	6130420
-0.01635	12018.20	15024.70	18031.50	21038.40	6020490
-0.01186	11784.80	14732.90	17681.30	20629.80	5903720
-0.00737	11537.40	14423.70	17310.10	20196.80	5779750
-0.00288	11275.70	14096.40	16917.30	19738.40	5648270
0.00160	10999.10	13750.50	16502.10	19253.80	5508950
0.00609	10706.80	13384.90	16063.10	18741.50	5361270
0.01058	10395.90	12995.90	15596.10	18196.40	5203630
0.01506	10067.10	12584.60	15102.20	17619.90	5036340
0.01955	9728.25	12160.60	14592.90	17025.30	4863150
0.02404	9387.59	11734.30	14080.90	16427.60	4688510
0.02853	9052.99	11315.50	13577.90	15840.20	4516590
0.03301	8731.22	10912.70	13094.00	15275.20	4350980
0.03750	8427.87	10532.90	12637.70	14742.30	4194680
0.04199	8147.24	10181.50	12215.50	14249.20	4050050
0.04647	7892.17	9862.09	11831.60	13800.90	3918670
0.05096	7663.92	9576.21	11488.00	13399.50	3801330
0.05545	7462.18	9323.51	11184.30	13044.70	3697960
0.05994	7285.25	9101.90	10918.00	12733.60	3607740
0.06442	7130.33	8907.86	10684.80	12461.10	3529220
0.06891	6993.84	8736.94	10479.40	12221.20	3460490
0.07340	6871.89	8584.26	10295.90	12007.00	3399470
0.07788	6760.64	8445.03	10128.70	11811.80	3344050
0.08237	6656.63	8314.90	9972.43	11629.40	3292330
0.08686	6557.02	8190.32	9822.86	11454.80	3242750
0.09135	6459.68	8068.60	9676.74	11284.30	3194140
0.09583	6363.19	7947.94	9531.92	11115.30	3145740
0.10032	6266.75	7827.35	9387.17	10946.40	3097120
0.10481	6170.08	7706.45	9242.04	10777.00	3048160
0.10930	6073.24	7585.34	9096.64	10607.30	2998930

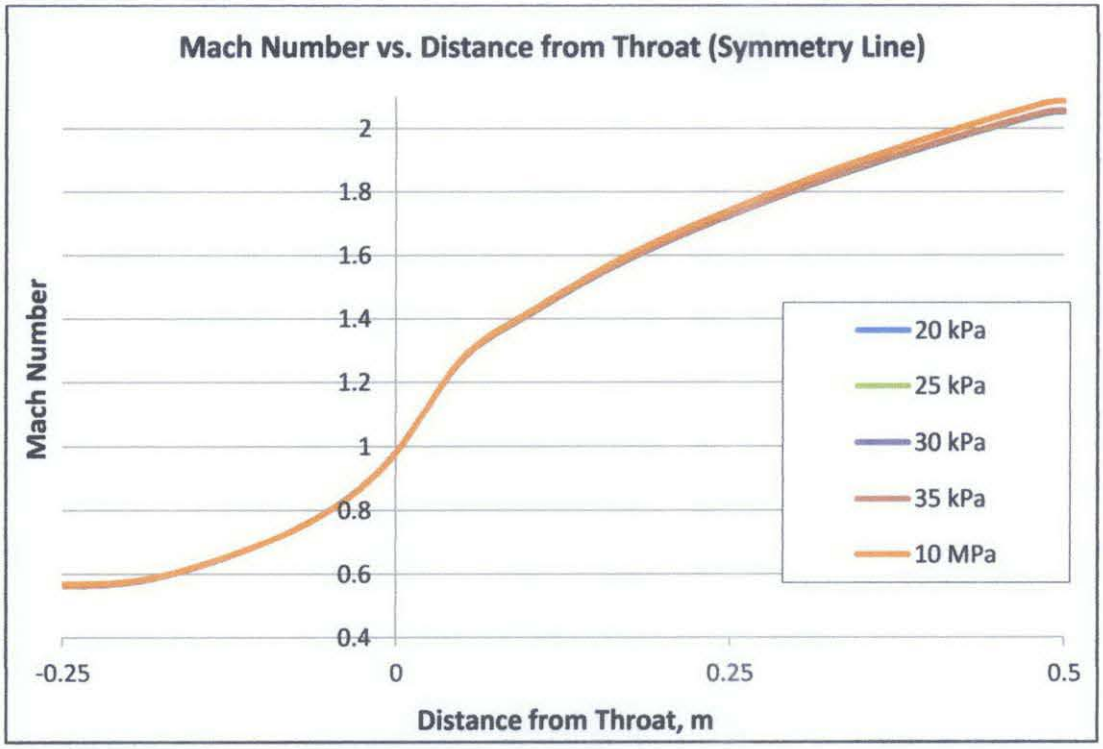
Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
0.11378	5976.55	7464.37	8951.40	10437.80	2949610
0.11827	5880.41	7344.09	8806.97	10269.20	2900470
0.12276	5785.29	7225.07	8664.02	10102.30	2851780
0.12724	5691.61	7107.83	8523.21	9937.93	2803790
0.13173	5599.77	6992.88	8385.13	9776.71	2756720
0.13622	5510.06	6880.59	8250.23	9619.20	2710760
0.14071	5422.72	6771.25	8118.89	9465.82	2666020
0.14519	5337.91	6665.08	7991.33	9316.87	2622620
0.14968	5255.72	6562.19	7867.72	9172.51	2580590
0.15417	5176.19	6462.63	7748.10	9032.83	2539970
0.15865	5099.30	6366.37	7632.46	8897.79	2500750
0.16314	5025.00	6273.36	7520.72	8767.31	2462910
0.16763	4953.20	6183.49	7412.76	8641.24	2426400
0.17212	4883.79	6096.61	7308.40	8519.39	2391160
0.17660	4816.65	6012.58	7207.47	8401.55	2357130
0.18109	4751.63	5931.22	7109.75	8287.46	2324240
0.18558	4688.59	5852.35	7015.03	8176.89	2292410
0.19006	4627.39	5775.77	6923.08	8069.55	2261560
0.19455	4567.88	5701.33	6833.69	7965.21	2231600
0.19904	4509.92	5628.83	6746.64	7863.62	2202460
0.20353	4453.38	5558.11	6661.75	7764.54	2174070
0.20801	4398.14	5489.03	6578.81	7667.76	2146360
0.21250	4344.09	5421.44	6497.68	7573.09	2119250
0.21699	4291.13	5355.22	6418.20	7480.34	2092710
0.22147	4239.19	5290.28	6340.25	7389.38	2066680
0.22596	4188.19	5226.51	6263.71	7300.08	2041110
0.23045	4138.07	5163.85	6188.50	7212.32	2015980
0.23494	4088.79	5102.23	6114.55	7126.03	1991250
0.23942	4040.31	5041.61	6041.80	7041.14	1966910
0.24391	3992.60	4981.96	5970.20	6957.61	1942940
0.24840	3945.65	4923.26	5899.74	6875.39	1919340
0.25289	3899.44	4865.48	5830.38	6794.46	1896080
0.25737	3853.97	4808.61	5762.13	6714.82	1873180
0.26186	3809.23	4752.67	5694.97	6636.45	1850630
0.26635	3765.22	4697.63	5628.90	6559.35	1828440
0.27083	3721.94	4643.50	5563.93	6483.53	1806600
0.27532	3679.39	4590.29	5500.06	6408.99	1785130
0.27981	3637.58	4538.00	5437.28	6335.73	1764010
0.28430	3596.50	4486.62	5375.60	6263.75	1743270
0.28878	3556.15	4436.16	5315.02	6193.06	1722900
0.29327	3516.53	4386.61	5255.53	6123.64	1702890

Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
0.29776	3477.64	4337.97	5197.14	6055.49	1683260
0.30224	3439.47	4290.23	5139.82	5988.60	1664000
0.30673	3402.00	4243.37	5083.56	5922.95	1645100
0.31122	3365.24	4197.38	5028.36	5858.53	1626570
0.31571	3329.16	4152.26	4974.19	5795.32	1608400
0.32019	3293.75	4107.98	4921.03	5733.29	1590580
0.32468	3259.00	4064.52	4868.86	5672.41	1573100
0.32917	3224.89	4021.86	4817.65	5612.66	1555960
0.33365	3191.41	3979.99	4767.38	5554.01	1539150
0.33814	3158.52	3938.87	4718.02	5496.42	1522660
0.34263	3126.23	3898.48	4669.55	5439.86	1506470
0.34712	3094.50	3858.81	4621.93	5384.30	1490580
0.35160	3063.32	3819.82	4575.13	5329.71	1474980
0.35609	3032.67	3781.50	4529.14	5276.05	1459660
0.36058	3002.54	3743.82	4483.92	5223.29	1444600
0.36506	2972.90	3706.76	4439.44	5171.41	1429810
0.36955	2943.74	3670.31	4395.68	5120.37	1415260
0.37404	2915.04	3634.43	4352.62	5070.14	1400940
0.37853	2886.79	3599.11	4310.24	5020.70	1386860
0.38301	2858.98	3564.34	4268.51	4972.02	1373000
0.38750	2831.59	3530.10	4227.41	4924.08	1359350
0.39199	2804.60	3496.36	4186.92	4876.86	1345910
0.39647	2778.02	3463.13	4147.04	4830.33	1332660
0.40096	2751.82	3430.38	4107.73	4784.48	1319610
0.40545	2726.00	3398.10	4068.99	4739.30	1306750
0.40994	2700.55	3366.29	4030.81	4694.77	1294080
0.41442	2675.46	3334.93	3993.17	4650.87	1281580
0.41891	2650.73	3304.01	3956.07	4607.59	1269250
0.42340	2626.35	3273.53	3919.49	4564.92	1257100
0.42789	2602.31	3243.49	3883.42	4522.86	1245110
0.43237	2578.61	3213.86	3847.87	4481.38	1233300
0.43686	2555.25	3184.65	3812.81	4440.49	1221640
0.44135	2532.21	3155.86	3778.25	4400.18	1210150
0.44583	2509.50	3127.47	3744.17	4360.44	1198810
0.45032	2487.12	3099.49	3710.58	4321.26	1187640
0.45481	2465.06	3071.91	3677.47	4282.64	1176620
0.45930	2443.31	3044.72	3644.84	4244.57	1165760
0.46378	2421.89	3017.94	3612.69	4207.07	1155050
0.46827	2400.79	2991.57	3581.03	4170.14	1144510
0.47276	2380.06	2965.65	3549.91	4133.84	1134130
0.47724	2359.75	2940.26	3519.43	4098.29	1123960

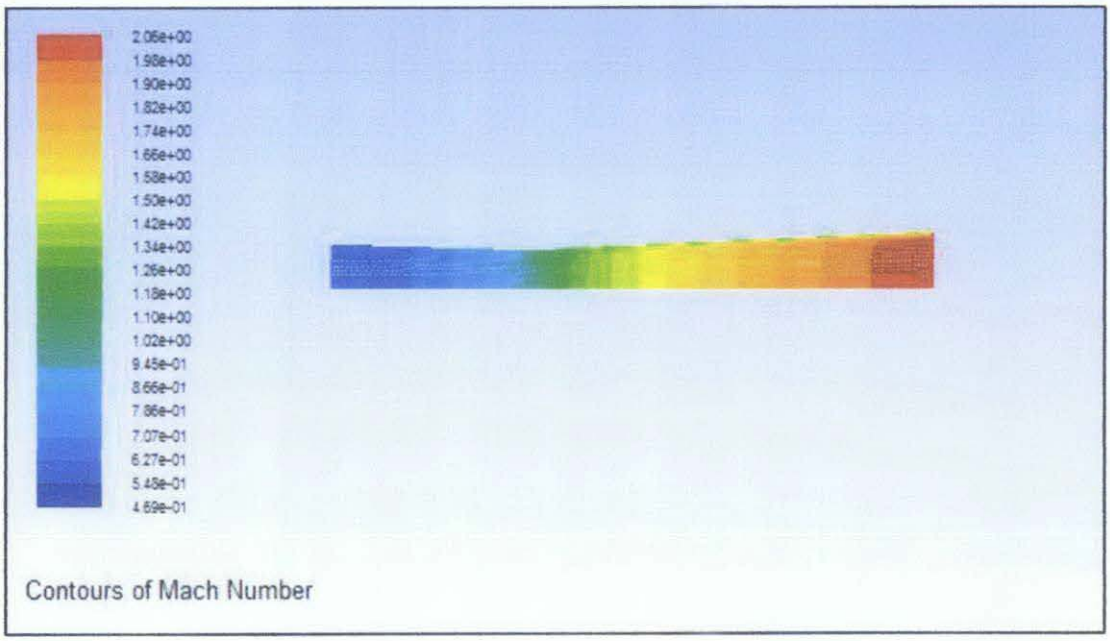
Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
0.48173	2340.05	2915.62	3489.84	4063.77	1114060
0.48622	2321.36	2892.26	3461.78	4031.03	1104640
0.49071	2304.66	2871.36	3436.67	4001.74	1096180
0.49519	2293.00	2856.76	3419.07	3981.21	1090200
0.49776	2287.31	2849.62	3410.40	3971.08	1087230
0.50000	2285.61	2847.47	3407.76	3967.99	1086340

APPENDIX IX: MANIPULATED VARIABLE – INLET PRESSURE (MACH NUMBER)

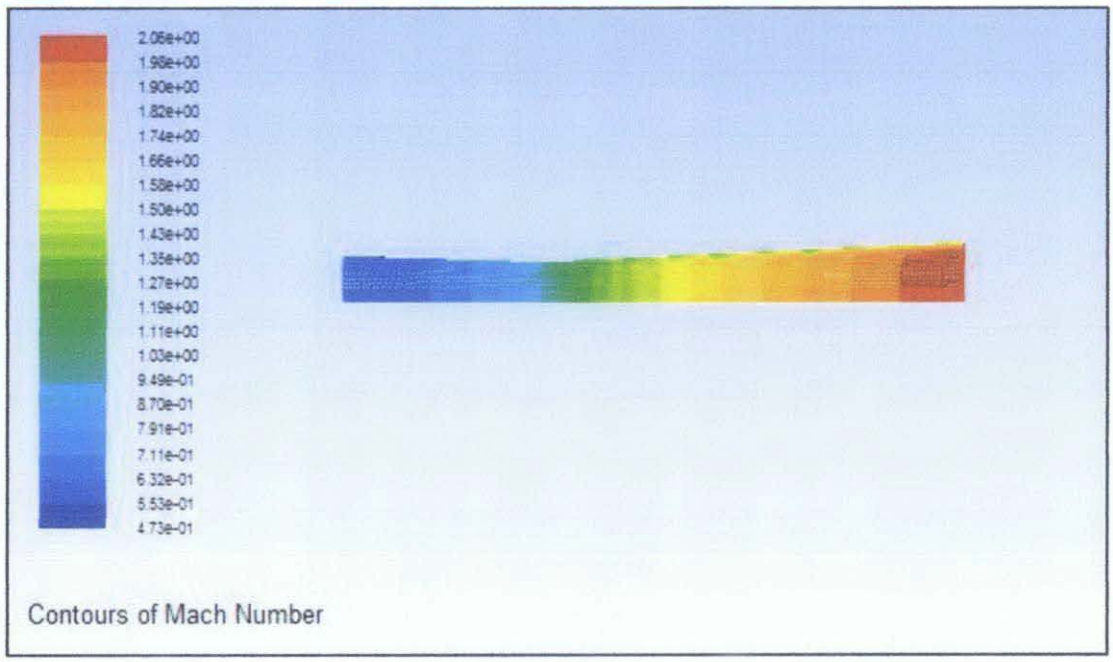
1. Mach Number Profile for Various Inlet Pressure



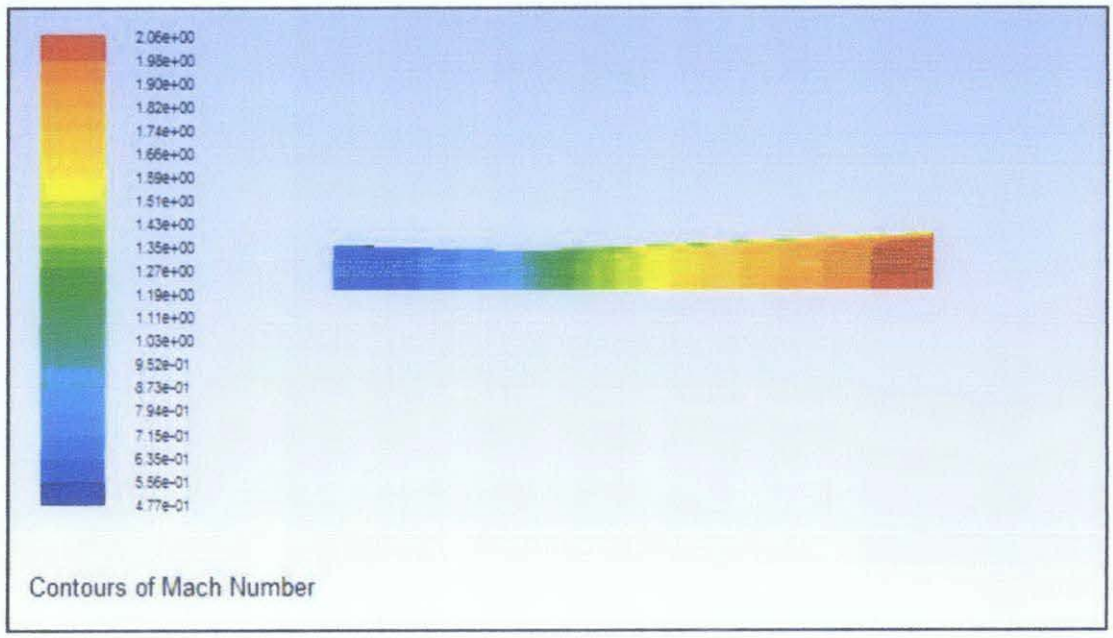
2. Contour Plot for Mach Number (P_{inlet} = 20 kPa)



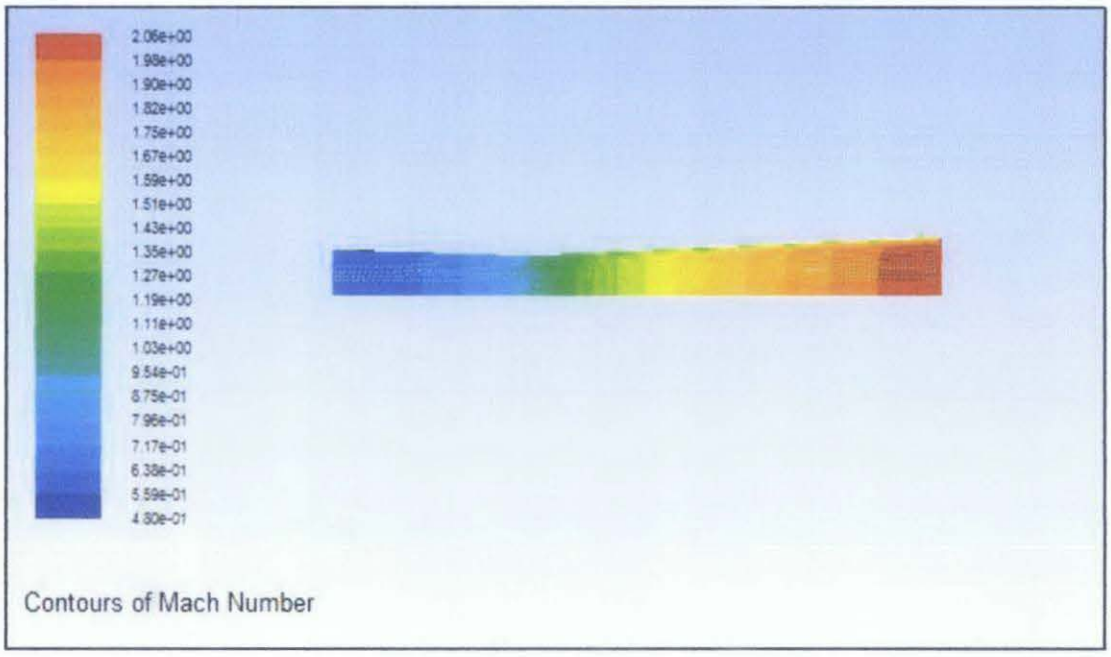
3. Contour Plot for Mach Number (P_{inlet} = 25 kPa)



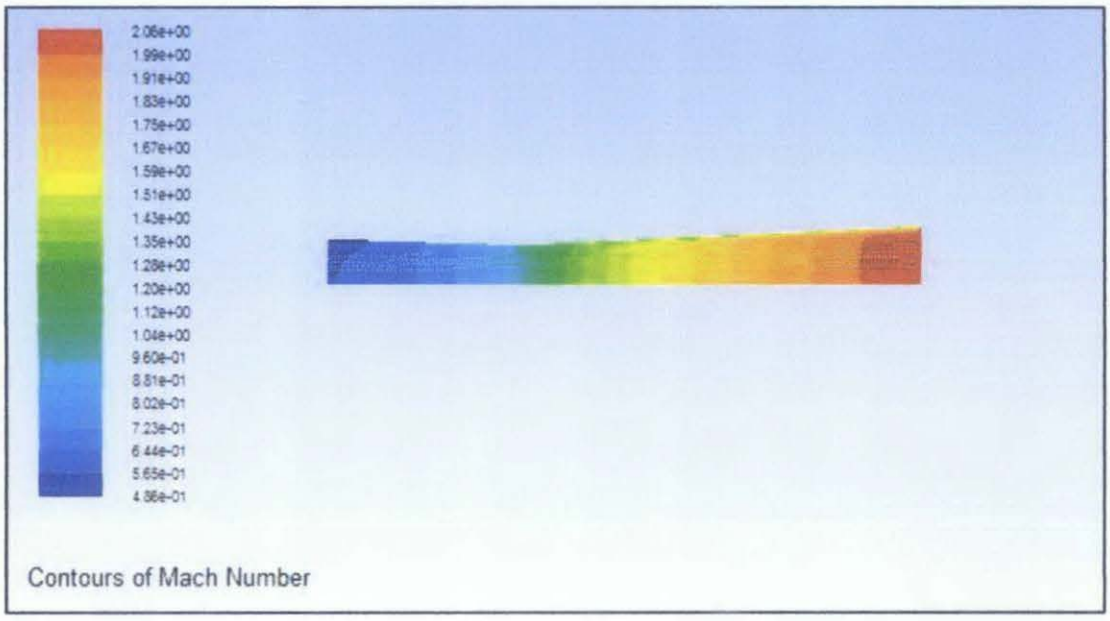
4. Contour Plot for Mach Number (P_{inlet} = 30 kPa)



5. Contour Plot for Mach Number (P_{inlet} = 35 kPa)



6. Contour Plot for Mach Number (P_{inlet} = 50 MPa)



Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
-0.25000	0.56308	0.56353	0.56388	0.56416	0.56939
-0.24776	0.56309	0.56354	0.56389	0.56417	0.56940
-0.24519	0.56315	0.56360	0.56395	0.56423	0.56943
-0.24071	0.56336	0.56381	0.56415	0.56443	0.56958
-0.23622	0.56372	0.56415	0.56449	0.56476	0.56981
-0.23173	0.56424	0.56466	0.56498	0.56525	0.57017
-0.22724	0.56492	0.56533	0.56564	0.56589	0.57066
-0.22276	0.56579	0.56618	0.56648	0.56672	0.57130
-0.21827	0.56687	0.56723	0.56752	0.56774	0.57213
-0.21378	0.56818	0.56852	0.56879	0.56900	0.57318
-0.20930	0.56976	0.57008	0.57033	0.57053	0.57451
-0.20481	0.57165	0.57195	0.57218	0.57237	0.57614
-0.20032	0.57388	0.57416	0.57437	0.57455	0.57812
-0.19583	0.57648	0.57674	0.57694	0.57710	0.58049
-0.19135	0.57946	0.57970	0.57989	0.58004	0.58326
-0.18686	0.58283	0.58305	0.58323	0.58337	0.58642
-0.18237	0.58655	0.58676	0.58692	0.58706	0.58996
-0.17789	0.59062	0.59081	0.59097	0.59109	0.59384
-0.17340	0.59504	0.59523	0.59537	0.59549	0.59809
-0.16891	0.59980	0.59997	0.60010	0.60021	0.60268
-0.16442	0.60482	0.60498	0.60510	0.60520	0.60753
-0.15994	0.61006	0.61020	0.61032	0.61041	0.61261
-0.15545	0.61547	0.61561	0.61571	0.61580	0.61786
-0.15096	0.62105	0.62117	0.62127	0.62135	0.62327
-0.14647	0.62677	0.62689	0.62698	0.62705	0.62884
-0.14199	0.63265	0.63275	0.63284	0.63290	0.63455
-0.13750	0.63867	0.63877	0.63884	0.63891	0.64041
-0.13301	0.64485	0.64494	0.64500	0.64506	0.64642
-0.12853	0.65118	0.65126	0.65132	0.65137	0.65260
-0.12404	0.65768	0.65775	0.65780	0.65784	0.65893
-0.11955	0.66435	0.66441	0.66445	0.66449	0.66544
-0.11506	0.67120	0.67124	0.67128	0.67131	0.67212
-0.11058	0.67823	0.67827	0.67830	0.67833	0.67900
-0.10609	0.68547	0.68550	0.68553	0.68554	0.68608
-0.10160	0.69293	0.69295	0.69296	0.69298	0.69337
-0.09712	0.70061	0.70062	0.70063	0.70064	0.70090
-0.09263	0.70854	0.70854	0.70855	0.70855	0.70867
-0.08814	0.71674	0.71673	0.71672	0.71672	0.71670
-0.08365	0.72521	0.72520	0.72519	0.72518	0.72502
-0.07917	0.73400	0.73397	0.73396	0.73394	0.73364
-0.07468	0.74312	0.74308	0.74306	0.74304	0.74260

Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
-0.07019	0.75260	0.75255	0.75252	0.75249	0.75192
-0.06571	0.76247	0.76241	0.76238	0.76234	0.76162
-0.06122	0.77276	0.77270	0.77266	0.77262	0.77176
-0.05673	0.78352	0.78345	0.78340	0.78336	0.78236
-0.05224	0.79479	0.79472	0.79466	0.79461	0.79347
-0.04776	0.80662	0.80654	0.80647	0.80642	0.80514
-0.04327	0.81906	0.81897	0.81890	0.81884	0.81743
-0.03878	0.83218	0.83208	0.83201	0.83194	0.83040
-0.03429	0.84604	0.84593	0.84585	0.84579	0.84412
-0.02981	0.86071	0.86060	0.86051	0.86044	0.85866
-0.02532	0.87626	0.87615	0.87606	0.87599	0.87410
-0.02083	0.89278	0.89266	0.89258	0.89250	0.89053
-0.01635	0.91034	0.91022	0.91013	0.91006	0.90801
-0.01186	0.92901	0.92889	0.92880	0.92873	0.92664
-0.00737	0.94886	0.94875	0.94866	0.94859	0.94648
-0.00288	0.96997	0.96987	0.96979	0.96972	0.96763
0.00160	0.99243	0.99234	0.99227	0.99221	0.99020
0.00609	1.01647	1.01639	1.01633	1.01628	1.01442
0.01058	1.04224	1.04218	1.04214	1.04210	1.04049
0.01506	1.06950	1.06946	1.06944	1.06942	1.06822
0.01955	1.09778	1.09778	1.09778	1.09778	1.09712
0.02404	1.12634	1.12637	1.12640	1.12642	1.12640
0.02853	1.15459	1.15466	1.15472	1.15476	1.15548
0.03301	1.18201	1.18213	1.18222	1.18229	1.18379
0.03750	1.20815	1.20831	1.20843	1.20853	1.21085
0.04199	1.23261	1.23281	1.23297	1.23310	1.23622
0.04647	1.25512	1.25537	1.25557	1.25572	1.25959
0.05096	1.27553	1.27583	1.27607	1.27625	1.28078
0.05545	1.29385	1.29419	1.29446	1.29467	1.29974
0.05994	1.31018	1.31056	1.31086	1.31109	1.31658
0.06442	1.32477	1.32518	1.32550	1.32576	1.33153
0.06891	1.33792	1.33836	1.33870	1.33897	1.34492
0.07340	1.34997	1.35043	1.35079	1.35108	1.35713
0.07788	1.36127	1.36175	1.36212	1.36242	1.36852
0.08237	1.37212	1.37261	1.37299	1.37330	1.37943
0.08686	1.38276	1.38326	1.38365	1.38396	1.39014
0.09135	1.39337	1.39388	1.39428	1.39460	1.40086
0.09583	1.40406	1.40458	1.40499	1.40531	1.41170
0.10032	1.41489	1.41542	1.41583	1.41616	1.42274
0.10481	1.42587	1.42641	1.42683	1.42717	1.43397
0.10930	1.43697	1.43753	1.43796	1.43831	1.44539

Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
0.11378	1.44816	1.44874	1.44919	1.44955	1.45692
0.11827	1.45940	1.45999	1.46045	1.46082	1.46853
0.12276	1.47062	1.47123	1.47171	1.47209	1.48015
0.12724	1.48178	1.48242	1.48291	1.48331	1.49173
0.13173	1.49284	1.49350	1.49401	1.49442	1.50321
0.13622	1.50375	1.50444	1.50497	1.50539	1.51455
0.14071	1.51450	1.51521	1.51576	1.51620	1.52571
0.14519	1.52505	1.52579	1.52636	1.52681	1.53666
0.14968	1.53540	1.53616	1.53675	1.53722	1.54741
0.15417	1.54553	1.54632	1.54693	1.54741	1.55792
0.15865	1.55544	1.55625	1.55688	1.55738	1.56820
0.16314	1.56514	1.56597	1.56662	1.56714	1.57824
0.16763	1.57462	1.57548	1.57614	1.57667	1.58805
0.17212	1.58390	1.58478	1.58546	1.58601	1.59765
0.17660	1.59299	1.59389	1.59458	1.59514	1.60703
0.18109	1.60189	1.60281	1.60352	1.60410	1.61621
0.18558	1.61063	1.61157	1.61230	1.61288	1.62521
0.19006	1.61922	1.62017	1.62092	1.62151	1.63404
0.19455	1.62767	1.62864	1.62940	1.63000	1.64272
0.19904	1.63600	1.63699	1.63775	1.63837	1.65127
0.20353	1.64422	1.64522	1.64600	1.64662	1.65970
0.20801	1.65234	1.65336	1.65415	1.65478	1.66803
0.21250	1.66038	1.66141	1.66221	1.66285	1.67628
0.21699	1.66835	1.66939	1.67020	1.67085	1.68444
0.22147	1.67625	1.67730	1.67812	1.67878	1.69255
0.22596	1.68409	1.68515	1.68599	1.68665	1.70060
0.23045	1.69187	1.69296	1.69380	1.69447	1.70860
0.23494	1.69961	1.70071	1.70156	1.70224	1.71656
0.23942	1.70730	1.70841	1.70928	1.70997	1.72448
0.24391	1.71495	1.71608	1.71695	1.71765	1.73236
0.24840	1.72255	1.72369	1.72458	1.72529	1.74021
0.25289	1.73011	1.73127	1.73217	1.73288	1.74802
0.25737	1.73763	1.73879	1.73971	1.74043	1.75580
0.26186	1.74509	1.74628	1.74720	1.74793	1.76353
0.26635	1.75251	1.75371	1.75465	1.75538	1.77122
0.27083	1.75987	1.76109	1.76204	1.76279	1.77887
0.27532	1.76718	1.76841	1.76938	1.77014	1.78647
0.27981	1.77443	1.77568	1.77666	1.77743	1.79401
0.28430	1.78163	1.78290	1.78389	1.78466	1.80150
0.28878	1.78876	1.79005	1.79106	1.79184	1.80894
0.29327	1.79584	1.79714	1.79816	1.79895	1.81630

Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
0.29776	1.80284	1.80416	1.80520	1.80600	1.82361
0.30224	1.80979	1.81113	1.81218	1.81299	1.83085
0.30673	1.81667	1.81802	1.81909	1.81991	1.83803
0.31122	1.82348	1.82486	1.82593	1.82676	1.84513
0.31571	1.83023	1.83162	1.83272	1.83355	1.85217
0.32019	1.83691	1.83832	1.83943	1.84028	1.85914
0.32468	1.84353	1.84496	1.84608	1.84694	1.86604
0.32917	1.85009	1.85154	1.85267	1.85353	1.87288
0.33365	1.85659	1.85805	1.85920	1.86007	1.87965
0.33814	1.86302	1.86450	1.86567	1.86654	1.88636
0.34263	1.86940	1.87090	1.87207	1.87296	1.89300
0.34712	1.87571	1.87723	1.87842	1.87931	1.89958
0.35160	1.88198	1.88351	1.88472	1.88562	1.90611
0.35609	1.88819	1.88974	1.89096	1.89186	1.91258
0.36058	1.89434	1.89591	1.89715	1.89805	1.91899
0.36506	1.90045	1.90203	1.90328	1.90420	1.92535
0.36955	1.90650	1.90810	1.90937	1.91029	1.93166
0.37404	1.91251	1.91413	1.91541	1.91633	1.93793
0.37853	1.91847	1.92011	1.92140	1.92233	1.94415
0.38301	1.92438	1.92604	1.92735	1.92828	1.95032
0.38750	1.93025	1.93193	1.93325	1.93419	1.95645
0.39199	1.93608	1.93777	1.93911	1.94005	1.96254
0.39647	1.94186	1.94357	1.94492	1.94587	1.96859
0.40096	1.94760	1.94932	1.95070	1.95165	1.97460
0.40545	1.95329	1.95504	1.95643	1.95739	1.98058
0.40994	1.95895	1.96071	1.96211	1.96308	1.98651
0.41442	1.96456	1.96634	1.96776	1.96873	1.99241
0.41891	1.97012	1.97192	1.97336	1.97433	1.99827
0.42340	1.97565	1.97746	1.97892	1.97990	2.00409
0.42789	1.98113	1.98296	1.98444	1.98542	2.00987
0.43237	1.98656	1.98842	1.98991	1.99089	2.01562
0.43686	1.99195	1.99382	1.99534	1.99633	2.02132
0.44135	1.99729	1.99919	2.00072	2.00171	2.02699
0.44583	2.00259	2.00450	2.00606	2.00705	2.03262
0.45032	2.00783	2.00977	2.01134	2.01234	2.03820
0.45481	2.01303	2.01499	2.01658	2.01759	2.04375
0.45930	2.01818	2.02015	2.02177	2.02278	2.04924
0.46378	2.02327	2.02526	2.02690	2.02792	2.05469
0.46827	2.02829	2.03031	2.03197	2.03299	2.06009
0.47276	2.03324	2.03528	2.03697	2.03799	2.06542
0.47724	2.03807	2.04013	2.04184	2.04287	2.07065

Inlet Pressure	20 kPa	25 kPa	30 kPa	35 kPa	10 Mpa
x	y	y	y	y	y
0.48173	2.04269	2.04478	2.04651	2.04755	2.07569
0.48622	2.04689	2.04900	2.05076	2.05180	2.08034
0.49071	2.05016	2.05228	2.05408	2.05512	2.08405
0.49519	2.05198	2.05413	2.05596	2.05701	2.08632
0.49776	2.05181	2.05398	2.05585	2.05689	2.08636
0.50000	2.05141	2.05358	2.05548	2.05652	2.08602